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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: John L. WADDELL et al.

Appln. No. 10/630,897

Date Filed: July 31, 2003

For: ACOUSTIC SHOCK WAVE ATTENUATING ASSEMBLY

Art Unit: 3641

Examiner: STEPHEN JOHNSON

Washington, D.C.

Atty.'s Docket: WADDELL=1

Date: June 23, 2006

Confirmation No. 9607

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Sir:

Transmitted herewith is a [XX] APPEAL BRIEF in the above-identified application.

[XX] Small Entity Status: Applicant(s) claim small entity status. See 37 C.F.R. §1.27.

[ ] No additional fee is required.

[XX] Fee for Appeal Brief $250.00.

	(Col. 1) CLAIMS REMAINING AFTER AMENDMENT		(Col. 2) HIGHEST NO. PREVIOUSLY PAID FOR	(Col. 3) PRESENT EXTRA EQUALS
TOTAL	* 10	MINUS	** 20	0
INDEP.	* 2	MINUS	*** 3	0
FIRST PRESENTATION OF MULTIPLE DEP. CLAIM				

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
x 25	$		x 50	$
x 100	$		x 200	$
+ 180	$		+ 360	$
ADDITIONAL FEE TOTAL	$	OR	TOTAL	$

* If the entry in Col. 1 is less than the entry in Col. 2, write "0" in Col. 3.

** If the "Highest Number Previously Paid for" IN THIS SPACE is less than 20, write "20" in this space.

*** If the "Highest Number Previously Paid for" IN THIS SPACE is less than 3, write "3" in this space.

The "Highest Number Previously Paid For" (total or independent) is the highest number found from the equivalent box in Col. 1 of a prior amendment of the number of claims originally filed.

[XX] Conditional Petition for Extension of Time
If any extension of time for a response is required, applicant requests that this be considered a petition therefor.

[ ] It is hereby petitioned for an extension of time in accordance with 37 CFR 1.136(a). The appropriate fee required by 37 CFR 1.17 is calculated as shown below:

Small Entity
Response Filed Within
[ ] First - $ 60.00
[ ] Second - $ 225.00
[ ] Third - $ 510.00
[ ] Fourth - $ 795.00
Month After Time Period Set

Other Than Small Entity
Response Filed Within
[ ] First - $ 120.00
[ ] Second - $ 450.00
[ ] Third - $ 1020.00
[ ] Fourth - $ 1590.00
Month After Time Period Set

[ ] Less fees ($_______) already paid for ___ month(s) extension of time on _________________.

[ ] Please charge my Deposit Account No. 02-4035 in the amount of $______________.

[XX] Credit Card Payment Form, PTO-2038, is attached, authorizing payment in the amount of $ 250.00.

[ ] A check in the amount of $______________ is attached (check no.).

[XX] The Commissioner is hereby authorized and requested to charge any additional fees which may be required in connection with this application or credit any overpayment to Deposit Account No. 02-4035. This authorization and request is not limited to payment of all fees associated with this communication, including any Extension of Time fee, not covered by check or specific authorization, but is also intended to include all fees for the presentation of extra claims under 37 CFR §1.16 and all patent processing fees under 37 CFR §1.17 throughout the prosecution of the case. This blanket authorization does not include patent issue fees under 37 CFR §1.18.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of:

John L. Waddell Jr., et al

Application No. 10/630,897

Filed: July 31, 2003

ACOUSTIC SHOCK WAVE ATTENUATING ASSEMBLY

Examiner: Stephen Johnson
Art Unit: 3641

APPEAL BRIEF

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TABLE OF CONTENTS

TABLE OF AUTHORITIES

Cases

Statutes

The present appeal is taken from the Notice of Panel Decision from Pre-Appeal Brief Review mailed May 30, 2006, in rejecting claims 13, 14, and 17-22. The specific rejections were made in an Office Action mailed April 4, 2006. A clean copy of these claims, double-spaced, appears in the Appendix to this Brief.

REAL PARTY IN INTEREST

The assignee of the subject application is BlastGard Technologies, Inc., 12900 Automobile Boulevard, Suite D, Clearwater, Florida 33762.

RELATED APPEALS AND INTERFERENCES

There are no related appeals and interferences.

STATUS OF THE CLAIMS

Claims 1-12 have been cancelled.

Claims 13, 14 and 17-22 are rejected.

Claims 15 and 16 are withdrawn.

The rejection of claims 13, 14 and 17-22 is appealed.

STATUS OF AMENDMENTS

The amendment filed March 23, 2006 has been entered.

SUMMARY OF CLAIMED SUBJECT MATTER

The subject matter claimed is a shock-attenuating assembly that is sufficiently flexible to wrap around any shaped structure. The assembly comprises:

(a) a first film of flexible resin material which is optionally water-impermeable or coated with water-impermeable material;

(b) a second film of flexible resin material which is optionally water-impermeable or is coated with a water-impermeable material, wherein the second film has attached pockets spaced from each other along the second film;

(c) wherein the first and second films are optionally porous with respect to at least one of acoustic wave, shock waves, or gas;

(d) wherein the second film has attached pockets spaced from each other along the second film;

(e) the first film is attached to the second film by a plurality of seams that surround the spaced pockets such that the assembly is sufficiently flexible to surround any shaped structure, and the assembly can be cut along the seams without losing any shock-attenuating material; and

(f) each of the pockets is filled with a shock-attenuating material having the flow properties of a liquid.

Support for this can be found in the specification as filed at paragraph 0016 on page 6, paragraph 0018 on page 7, paragraph 0021 on page 8 and paragraph 0023 on page 9.

The shock attenuating material can be perlite (paragraph 0024, page 9), an aqueous foam (paragraphs 0040 and 0041, page 14), an aerogel (paragraph 0029, page 11).

Optionally, the pockets of the shock attenuating assembly can contain at least one of fireproofing materials, heat insulating materials, intumescent materials, and radiation insulating materials (paragraph 0019, page 7).

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 13 and 17-22 are rejected under 35 U.S.C. 102(b) as being anticipated by Colle, U.S. Patent No. 4,184,788. The Examiner alleges that Colle describes an assembly comprising:

(a) a first film of a flexible resin material (54, column 4, lines 3-8);

(b) a second film of flexible resin material (53, column 4, lines 3-8);

(c) pockets (Figures 1, 2);

(d) a plurality of seams (57);

(e) a shock wave attenuating material (column 4, lines 23-42)

Claims 13 and 17-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Munch, U.S. Patent No.

4,700,706 in view of Colle. The Examiner's position is that Munch discloses an assembly comprising:

(a) a first film of flexible material (5);

(b) a second film of a flexible material (3);

(c) pockets (Figures 1-3);

(d) a plurality of seams (column 3, lines 17-26) and

(e) a shock wave attenuating material (column 3, lines 40-67).

Colle is cited for showing a flexible film that is a polyamide.

Claims 13 and 17-22 are rejected under 35 U.S.C. 102(b) as being anticipated by Poux, U.S. Patent No. 2,602,302. The Examiner states that Poux disclose an assembly comprising:

(a) a first film of a flexible polyamide material (10 or 7);

(b) a second film of a flexible polyamide material (11 or 8);

(c) pockets (see Figures 6, 7, 8);

(d) a plurality of seams (6, column 3, lines 40-57) and

(e) a shock wave attenuating material (column 4, line 7).

Claims 13, 17 and 19-21 are rejected under 35 U.S.C. 102(b) as being anticipated by Ava, U.S. Patent No. 3,795,994. the Examiner states that Ava discloses an assembly comprising:

(a) a first film of a flexible resin material (1, column 1, lines 18-23);

(b) a second film of a flexible resin material (2, column 1, lines 18-23);

(c) pockets (see Figures 1-6);

(d) a plurality of seams (4, 5, 6, 7) and

(e) a shock wave attenuating material (column 2, lines 16-18).

Claims 13, 17, 18, 20 and 22 are rejected under 35 U.S.C. 102(b) as being anticipated by Bertram, U.S. Patent No. 4,716,598. The Examiner's position is that Bertram discloses an assembly comprising:

(a) a first film of a flexible polyamide material (17; column 2, lines 46-47);

(b) a second film of a flexible polyamide material (19; column 2, lines 46-47);

(c) pockets (see Figures 1-2);

(d) a plurality of seams (3) and

(e) a shock wave attenuating material (21; column 2, line 48).

Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bertram in view of Symons, U.S. Patent No. 5,309,690. The Examiner concedes that Bertram does not

disclose a shock wave attenuating material that is perlite. Applicant is said to substitute one enclosed aggregate material for another in an analogous art setting as explicitly encouraged by both the secondary reference (see column 5, lines 12-20 of Symons).

ARGUMENT

I. Colle, U.S. Patent No. 4,184,788 Does Not Anticipate Claims 13 and 17-22.

Contrary to the Examiner's assertion, Colle only discloses materials that include any of the conventionally known cementitious slurries, which can harden when disposed under a body of water; or various forms of commercially available flowable asphalts (column 4, lines 39-42). This is not at all the same as the shock-attenuating material claimed herein. As recited in claim 13, the shock attenuating material has the flow properties of a liquid. It is clear from Colle that the filler for the pockets is a material **that can harden when disposed under a body of water**. The Colle device is a form for erosion control structures, and the only time the material added is flowable is when it is introduced into the pockets so that the material flows into the pockets and fills the entire space (column 4, lines 36-38).

According to IPCS, International Programme on Chemical Safety, a collaborative venture of the World Health

Organization, United Nations Environment Programme, and the 'International Labour Organisation, the melting point of asphalts is 54-173°C. Even if the asphalt is flowable, it is still a solid at ambient temperatures, and it is characterized as a solid.

Thus, it is clear that the hardened cementitious slurries or commercially available flowable asphalts cannot possibly be a shock attenuating material as claimed herein.

Is respectfully submitted that the material of Colle is not the type of shock-attenuating material that would be useful in a shock-attenuating assembly as claimed herein. In the present application, in paragraph 0025, the term "mechanical properties and flow properties of a fluid" refers to the ability to the attenuating medium to act in the nature of a liquid to resist relative displacement by surface tension and viscous forces, as well as the ability to substantially scatter and disperse pressure conditions transmitting therethrough by virtue of multitudinous curved surfaces dividing gaseous and solid or liquid phases, and enabling the generation of turbulent flow fields by transmitting pressure conditions. More briefly, these terms may be taken as referring to the ability to resist applied shear forces in the nature of fluid viscosity. The attenuating medium assumes the

shape of the cells or recesses, while at the same time resisting applied shear forces in the nature of viscosity.

The shock-attenuating assembly claimed herein is for attenuating shock waves from blasts resulting from explosive devices and the like. Explosive devices produce blast fragments emanating both from the device and from material close to the point of explosion. Additionally, explosive devices produce shock waves, which produce the highly damaging phenomenon known as "blast." Pressure waves can be reflected and diffracted by phase boundaries, such as liquid droplets or solid particulates suspended in air. These deflections serve to increase the distance that the wave travels by a process of multiple reflections and diffractions. Scattering and dispersion thus produce more attenuation because they smear the discontinuity leading the shock wave, the result of which is a significant drop in pressure in the material.

The mechanisms of the shock attenuating materials used in the herein claimed shock attenuating assembly are discussed in the specification at paragraphs 0045 through 0049. When the blast attenuating material is an aqueous foam, substantial energy is removed from an incident pressure wave by scattering at the multiple interfaces presented by bubble wall liquids and the entrapped gas which comprise the basic units of aqueous foam structures, and through the displacement

of the liquid in the aqueous foam. A similar effect is obtained when solid bed materials are used, particularly solids with entrained gas, such as vermiculite and organic solid foams. Additional energy and thus attenuating of transmitting pressure waves is accomplished by cancellation. The decay of the wave is related to the work done as the wave travels through the medium and how long it remains in the medium. Perlite and foam shock absorbing materials dramatically reduce the sound speed of the shock, as scattered, slowed, and reflected waves become coincident. The propagation paths of pressure waves through the shock absorbing material are substantially lengthened by their scattering and disposition.

It is clear from the specification that the presently claimed assembly is for blast or shock attenuation, not for any other purpose. The preamble of the claims, "A shock-attenuating assembly", defines the invention, which is further characterized by the fact that the assembly includes "a shock wave attenuating material having the flow properties of a liquid." As the Federal Circuit stated in *Corning Glass Works v. Sumitomo Elec. U.S.A., Inc*, 868 F.2d 1251, 9 USPQ2d 1962 (Fed. Cir. 1989): "The determination of whether preamble recitations are structural limitations or mere statements of purpose or use can be resolved only on review of the entirety

of the patent to gain an understanding of what the inventors actually invented and intended to encompass by the claim."

The present case is similar to the situation in *Corning*, supra, in that the defendant alleged that the claim was anticipated by a disclosure of a substantially transparent luminescent glass in the form of a fiber comprised of a doped silica core having a sheath of silica. Although nothing in the cited patent discussed the use of the fiber as an optical waveguide, the defendant alleged that the fiber "inherently" could function as a waveguide. In *Corning*, the plaintiff defined the preamble words "an optical waveguide" in the specification. In *Corning*, it was clear from the specification that the inventors were working on the particular problem of an effective optical communication system, not on general improvements in conventional optical fibers. "To read the claim in light of the specification indiscriminately to cover all types of optical fibers would be divorced from reality. The invention is restricted to those fibers that work as waveguides as defined in the specification, which is not true with respect to fibers constructed with the limitations of paragraph (a) and (b) only. Thus, we conclude that the claim preamble in this instance does not merely state a purpose or intended use of the claimed structure… Rather, those words do give 'life and

meaning' and provide further positive limitations to the invention claimed."

In a similar manner, the present specification defines a shock-attenuating assembly as one providing shock wave, and therefore blast, attenuation capabilities in both confined spaces and unconfined areas, as described in paragraphs 0016 and 0020. The problems in dealing with explosive devices are presented in great detail in the "Background" section of the present application, at paragraphs 0002 to 0005.

According to IPCS, International Programme on Chemical Safety, a collaborative venture of the World Health Organization, United Nations Environment Programme, and the 'International Labour Organisation, the melting point of asphalts is 54-173°C. Even if the asphalt is flowable, it is still a solid at ambient temperatures, and it is characterized as a solid.

Thus, it is clear that the hardened cementitious slurries or commercially available flowable asphalts cannot possibly be a shock attenuating material as claimed herein.

II. Claims 13 and 17-22 Are Not Obvious Over Munch in View of Colle.

The Examiner asserts that Munch discloses a shock wave attenuating material at column 3, lines 40-67. In reality, Munch at column 3, lines 40-42, discloses that the

filling 2 comprises a substantially **non-flowable** mixture of water, glycol, salt and finely dispersed silicic acid. [emphasis added] In contrast thereto, the shock attenuating material recited in the claims at bar has the flow properties of a liquid. Thus, Munch **teaches away** from the presently claimed assembly. Munch discloses a pack for hot and cold therapy, and has nothing at all to do with shock attenuation.

Cole adds nothing to Munch, because, as noted above, Colle also discloses an assembly in which the pockets are filled with a solid material. With respect to the showing in Colle that the film can be polyamide, it is respectfully submitted that this showing only applies to claim 22, the only claim that recites that the film is a polyamide resin.

III. Claims 13 and 17-22 Are Not Anticipated By Poux.

As noted above, the assembly claimed herein is a blast mitigating assembly which includes a blast-mitigating material enclosed in pockets on a flexible laminate. Poux discloses a combination ice and hot pack that consists of independent and sealed fluid-containing compartments, with the compartments spaced from each other by a relatively wide and flat, thin web of material whereby the article is so flexible that it can be folded upon itself whether the compartments contain a hot fluid or a solidly frozen fluid (column 2, lines 1-9). When the fluid inside the pack is frozen, it cannot possibly act as a material having the flow properties of a

liquid. Additionally, there is no indication in Poux that water, either in liquid or solid form, is a suitable blast-attenuating material.

In the present application, the claim preamble defines the invention for which patent protection is sought, namely, "a flexible shock-attenuating assembly." It is well settled that a "claim preamble has the import that the claim as a whole suggests ** for it." *Bell Communications Research, Inc. v. Vitalink Communications Corp.*, 55 F.3d 615, 620, 34 USPQ2d 1816, 1820 (Fed. Cir. 1995). Where a patentee uses the claim preamble to recite structural limitations of his claimed invention, the PTO and courts give effect to that usage. See id.; *Corning Glass Works v. Sumitomo Elec. U.S.A., Inc*, 868 F.2d 1251, 1257, 9 USPQ2d 1962, 1966 (Fed. Cir. 1989).

The determination of whether preamble recitations are structural limitations or mere statements of purpose or use "can be resolved only on review of the entirety of the patent to gain an understanding of what the inventors actually invented and intended to encompass by the claim." *Corning Glass Works*, 868 F.2d at 1257. The inquiry involves examination of the entire patent record to determine what invention the patentee intended to define and protect. See *Bell Communications*, 55 F.3d at 621 (looking to patent specification to determine whether claimed invention includes preamble recitations); *In* re *Paulsen*, 30 F.3d 1475, 1479, 31 USPQ2d (BNA) 1671, 1674 (Fed. Cir. 1994) (examining "patent as a whole"); *Vaupel Textilmaschinen KG v. Meccanica Euro Italia*

SPA, 944 F.2d 870, 880, 20 USPDQ2d (BNA) 1045, 1053 (Fed. Cir. 1991) (looking to claims, specification, and drawings); *Gerber Garment Tech., Inc. v. Lectra Sys., Inc.*, 916 F.2d 683, 689, 16 USPQ2d 1436, 1441 (Fed. Cir 1990) (noting that preamble recitations provided antecedent basis for terms used in body of claim); *Corning Glass Works*, 868 F.2d at 1257 (considering the specification's statement of the problem with the prior art); *Kropa v. Robie*, 38 CCPA 858 F.2d 150, 152, 88 USPQ 478 (1951), (noting that preamble sets out distinct relationship among remaining claim elements).

IV. Claims 13, 17 and 19-21 Are Not Anticipated by Ava, U.S. 3,795,994.

Ava discloses air-cushion socks. The air cushioning comprises two relatively thin superposed sheets of polyvinyl chloride or other suitable heat-weldable materials, the sheets being die-cut to the desired shape and welded along their edges to form separate compartments, each compartment containing a sufficient quantity of air, column 1, lines 19-26.

The claims of the present application recite that the pockets are filled with **shock-attenuating material.** As stated in paragraph 0023, the shock attenuating material claimed is a flowable medium which impedes shocks… Substantial energy from the shock wave is absorbed by the attenuating medium, enhanced by confinement within the cells or recesses. It is self-evident that the shock attenuating

material is not air, because if it were air, there would be no reason to have a shock attenuating assembly.

The introductory language in the claims, "a flexible shock attenuating assembly", as in *In re Bulloch,* 604 F.2d 1362, 203 USPQ 171 (CCPA 1979), is more than a mere statement of purposes. That language is essential to particularly point out the invention defined by the claims. See *Kropa v. Robie,* 38 CCPA 858, 187 F.2d 150, 88 USPQ 478 (1951). As in *Bulloch*, the claims must be read in the light of the specification and the declarations of record. It is clear that the intent of applicants is to limit the claims to flexible shocks-attenuating assemblies. The cushion of Ava is not a shock attenuating assembly containing a shock attenuating material, as the Ava cushions contain only air.

V. Claims 13, 17, 18, 20 and 22 Are Not Anticipated by Bertram, U.S. 4,716,598.

First of all, it should be noted that only claim 22 recites that the film of flexible resin material is polyamide, the "flexible film" of which the two layers of fabric are comprised.

Bertram discloses a heat-insulating fabric article comprising at least two layers of flexible fabric secured together by a plurality of spaced apart seams arranged in a network across the fabric to form columns or rows of pockets, wherein said pockets are each substantially filled with closed

particles of polystyrene, the amount of polystyrene filing in each pocket being sufficient to occupy the space therein to permit movement of the particles one against the other but to resist migration thereof to other regions of the pocket (column 1, lines 33-44). In one embodiment, described at column 2, line 48, the filling in the pockets comprises polyester beads. It is not understood how polyester beads could be considered to be shock-absorbing material, since Ava clearly states that the filling in the pockets is for heat insulation. There is no suggestion of shock attenuation in the jacket.

VI. Claim 14 is Not Unpatentable Under 35 U.S.C. 103(a) Over Bertram in View of Symons, U.S. 5,309,690.

As discussed *supra*, there is nothing in Bertram that even suggests a shock attenuating assembly, as Bertram only discloses a heat-insulating jacket. Symons adds nothing to this disclosure other than to state that inorganic insulating material can be exfoliated vermiculite, expanded perlite, mineral wool, expanded clay, expanded fly ash, glass fiber, expanded graphite, expanded silicate, zeolite or glass foam, or a mixture of two or more thereof. These materials provide an insulating and fire-proof filing for the open cellular core of the composite panel.

It is not seen how one skilled in the art would expect to put the insulating materials in Symons into the

pockets of Bertram's heat-insulating jacket. There is nothing in Symons that suggests substituting inorganic insulating material for polystyrene or polyester beads. In fact, given that the inorganic minerals recited in Symons may be rigid and sharp edged, one would not expect that they would be used for insulating a jacket to be worn. Moreover, Symons also discloses that the cores of the panel are filled with a material which releases water at elevated temperatures, in addition to the inorganic material. The purpose of these materials is to reduce the temperature in the panel in the event of a fire.

Symons discloses a composite panel to be used for a building panel. The purpose of the core material is for heat and sound insulation, not for shock attenuation. While the Bertram jacket is designed to be heat insulating, there is no motivation to combine Bertram with Symons, because such a combination would result in a jacket filled with a cellular core sandwiched between the two layers of fabric, the cellular core containing a natural fiber material and a filler composition comprising a mixture of an inorganic insulating material and a material which releases water at elevated temperatures. This is certainly not the shock attenuating assembly as claimed herein.

The declaration of one of the inventors, James Gordon, was submitted with the amendment filed March 23, 2006, in order to demonstrate that the herein claimed invention satisfied a long-felt need for material that can be readily used to absorb the effects of a blast, and that can be readily conformed to any desired shape and size. The U.S. government has placed BlastGard, maker of BlastWrap, the product covered by the present claims, as the sole source. BlastGard is the only U.S. company that offers a bomb resistant trash receptacle.

There is nothing in any of the patents cited above that even suggests that the assemblies disclosed therein can be used for blast protection. It is well settled law that claims are to be construed in light of the specification, and both are to be read with a view to ascertaining the invention, *Seymour v. Osborne*, 11 Wall. 516, 547 (1861); *Schriber-Schroth Co. v. Cleveland Trust Co.*, 311 U.S. 211 (1940); *Schering Corp. v. Gilbert*, 153 F.2d 428 (1946). It is clear from the specification and claims of the present application that applicants claim a shock-attenuating assembly that is designed to protect objects and environments from the effects of a blast or explosion. Trash receptacles in the D.C. area Metro system are lined with a flexible assembly as claimed herein.

The Examiner has cited no references that disclose the invention claimed herein, namely, a blast attenuating assembly sufficiently flexible to wrap around any shaped structure, comprising a first and second film of flexible material that are optionally water-impermeable or treated with a water-impermeable material, wherein the first film is attached to the second film by a plurality of seams forming pockets between the two films, and wherein each of the pockets is filled with a shock wave attenuating material having the flow properties of a liquid.

For the reasons given above, it is respectfully submitted that the claims at bar are allowable over the cited art.

Applicant respectfully requests reversal of the Examiner's rejections.

Respectfully submitted,

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CLAIMS APPENDIX

16. A shock-attenuating assembly that is sufficiently flexible to wrap around any shaped structure, said assembly comprising, in combination,

(a) a first film of flexible resin material, wherein said first film of flexible resin material is optionally water-impermeable or is optionally coated with a water-impermeable material;

(b) a second film of flexible resin material, wherein said second film of flexible resin material is optionally water-impermeable or is optionally coated with a water-impermeable material, wherein said second film of flexible resin material has attached pockets spaced from each other along the second film;

(c) the first film attached to the second film via a plurality of seams, wherein the seams surround each of the spaced pockets in such a manner as to make the assembly sufficiently flexible to surround any shaped structure;

(d) each of the pockets filled with a shock wave attenuating material having the flow properties of a liquid.

14. The flexible shock-attenuating assembly according to claim 13 wherein the shock attenuating material is perlite.

17. The flexible shock-attenuating assembly according to claim 13 further including within the pockets at least one material selected from the group consisting of fireproofing materials, heat insulating materials, intumescent materials, and radiating insulating materials.

18. The flexible shock-attenuating assembly according to claim 13 further including within the pockets a fire retarding material.

19. The flexible shock-attenuating assembly according to claim 13 wherein the assembly is adapted and constructed so that the assembly can be cut along the seams so that shock attenuating material remains confined in the pockets.

20. The flexible shock-attenuating assembly according to claim 13 wherein the flexible films are porous with respect to at least one of acoustic waves, shock waves, or gas.

21. The flexible shock-attenuating assembly according to claim 13 wherein the flexible sheets are water-impermeable.

22. A flexible shock-attenuating assembly comprising in combination:

(a) a first strip of a water-impermeable polyamide resin material;

(b) a second strip of a water-impermeable polyamide resin material, said second strip having attached pockets spaced from each other along the second strip;

the first strip attached to the second strip via a plurality of seams, the seams surrounding each of the spaced pockets in such a way as to make the assembly flexible.

EVIDENCE APPENDIX

AVA, U.S. Patent No. 3,795,994, March 12, 1974

BETRAM, U.S. Patent No. 4,716,598, January 5, 1988

COLLE, U.S. Patent No. 4,184,788, January 22, 1980

Declaration of James Gordon and papers submitted, and a statement that the evidence was inserted in the record by the Examiner March 23, 2006

MUNCH, U.S. Patent No. 4,700,706, October 20, 1987

POUX, N. J., U.S. Patent No. 2,602,302, June 13, 1947

SHARPE, Kevin J., "Discussion of the Effects of Blast Overpressure on the Human Body With Reference to Explosion Resistant Trash Receptacles", BlastGard International, Inc.

SYMONS, U.S. Patent No. 5,309,690, May 10, 1994

The "Circle of Injury", BlastWrap-Mitigated

"The Troubles", Principal Events

"Thermal Injuries And Prevention/Mitigation Measures", 27 October 2005, 1-19 p.

USPTO Patent Database Search Results

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ATTY.'S DOCKET: WADDELL=1

In re Application of:	Art Unit: 3641
John L. WADDELL et al.	Examiner: STEPHEN JOHNSON
Appln. No.: 10/630,897	Washington, D.C.
Filed: July 31, 2003	Confirmation No. 9607
For: ACOUSTIC SHOCK WAVE ATTENUATING ASSEMBLY	

DECLARATION UNDER 37 CFR 1.132

Customer Service Window, Mail Stop Amendment
Honorable Commissioner for Patents
U.S. Patent and Trademark Office
Randolph Building, Mail Stop
401 Dulany Street
Alexandria, VA 22314

Sir:

I, James Gordon, do hereby declare that I am one of the inventors of the above-identified application.

The above-identified application claims a blast attenuating assembly comprising a first film of flexible resin material and a second film of flexible resin material. The second flexible resin material has attached pockets spaced from each other along the second film. The first film of flexible material is attached to the second film via a plurality of seams, wherein the seams surround each pocket in such a manner as to make the assembly sufficiently flexible to surround any shaped structure. Each of the pockets is filed

with a shock wave attenuating material having the flow properties of a liquid.

BlastGard International makes a product called BLASTWRAP® which is covered by the claims of the above-identified application. Appendix A describes BLASTWRAP®.

Appendix B describes sole source justification for BLASTWRAP® to be placed onto the GSA Advantage schedule, as Blastgard International is the only U.S. company that offers a bomb resistant trash receptacle. By way of information, these trash receptacles are lined with BLASTWRAP®.

Appendix C is a copy of a letter from Mark Jannot, editor of *Popular Science* informing BlastGard International that BLASTRWRAP® has been chosen to receive a 2005 Best of What's New Award from the magazine.

Appendix D is a draft of a report authored by Kevin Sharpe of how BLASTWWRAP® can be used to protect pipelines from blast damage.

It is clear from the Appendices that BLASTWRAP® is a unique product that fulfills a long-felt need for blast attenuation.

I hereby further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that all statements made on information and belief are

believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 81 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

James Gordon

2/20/06
Date

APPENDIX A

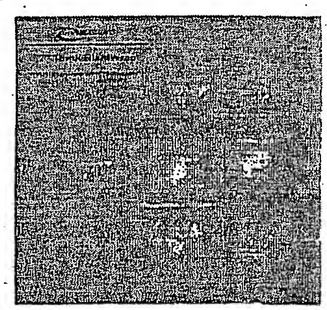
WHAT IS BLASTWRAP®?

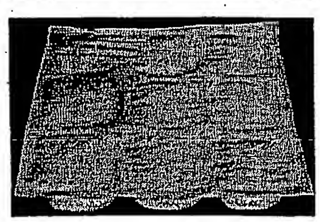
Product Overview:

1. BlastWrap® is a unique, scientifically engineered, passive blast mitigation technology.
2. BlastWrap® is designed to remove most of the energy from explosions of all types, including high explosives, gas, dust and mist explosions.
3. BlastWrap® works by dissipating blast energy through irreversible processes while at the same time extremely rapidly quenching the blast fireball or flame front created as a result of an explosion.
4. BlastWrap® uses "COTS" attenuating materials, including fusible salts to quench the thermal output and two-phase volcanic materials to mechanically "smear" the shock, kill shock holing and dramatically reduce the blast impulse and pressures (incident and reflected pressure) of explosions.
5. BlastWrap® prevents sympathetic detonation, in which one explosion triggers another explosion, and another in a chain reaction that rapidly becomes a mass detonation.
6. BlastWrap® kills afterburn and, therefore, kills post-blast fires.
7. By marrying ballistic armor to the backside, BlastWrap® enhances the performance of all armor in fragment management.
8. BlastWrap® can be effectively used in confined and unconfined environments.
9. BlastWrap® products will save lives, reduce blast injuries and protect valuable assets.

This unique Passive Mitigation system:

1. Works 7/24/365
2. Quenches blast thermal output, the fireball
3. Kills afterburn and post blast fires
4. Dramatically reduces blast impulse and pressure
5. Does not dispense chemical extinguishants
6. Uses no power, alarms, sensors, or activation systems
7. Is nontoxic and ecologically friendly
8. Is lightweight, flexible and easy to install
9. Is customizable and easy to install
10. Does not require maintenance
11. Does not create hazardous fragments
12. Never fails





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APPENDIX B

Subject: Proposed Sole Source Justification to procure MTR 91 and MTR 101 mitigated trash receptacles.

A survey of products being marketed through known literature, to include the GSA Advantage schedule, finds that BlastGard International, Inc. is the only U.S. Company which offers a bomb resistant trash receptacle which **mitigates the effects of bomb blast**. This blast mitigation is made possible by the integration of BlastWrap™, BlastGard International's unique, patent-pending blast mitigation technology.

There are four threats from an explosion inside a trash receptacle, each of which must be addressed and removed or significantly reduced if the public are to be given a meaningful level of protection. These four threats are:

- Primary fragmentation from materials in contact with the charge
- Secondary fragments from around the charge and pieces of the trash receptacle should it fail
- Blast overpressure
- Fireball

Accordingly, the following justification for sole source purchase is made based on:

- Unique Technology,
- Proven by extensive testing,
- Established Government pricing,
- Previous Government procurements, and
- Responsive delivery schedule

1. **Unique Technology** The MTR units are the only receptacles that deal with **all four** threats. Contrary to claims made by other manufacturers of trash receptacles, blast is not directed up and away from the unit and surrounding public but flows out at high velocity both vertically and horizontally, spreading outwards as an expanding hemispherical wave. This blast wave is potentially lethal, causing severe damage to the lungs, central nervous system, gastro-intestinal tract and the eardrums. If the explosion happens in an internal environment such as a subway, the blast wave is enhanced by reflections and its lethality is greatly increased. BlastGard's trash receptacles significantly reduce this threat by mitigating the blast pressures at source by up to 85%, from that which can cause fatal injuries to below the level that will generate physiological injury (at a few feet from the unit). Another important issue is that of the fireball. The fireball from a 12 lb TNT charge is nearly 20 feet in diameter and can cause third degree burns. The

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MTR trash receptacles extinguish the fireball in a few thousandths of a second and thereby dramatically reduce the potential for burns.

2. **Testing** The trash receptacle body is made from multiple steel layers and has been designed to with stand a detonation of twelve pounds of TNT for the MTR101 and four pounds for the MTR91. The units have been tested by independent US government organizations to meet and exceed the most stringent standards available today (the UK Home Office Scientific Development Bureau litter bin testing specification, both units have reached the top **level for protection, ten stars**). The units can withstand maximum charge detonation against the bottom and side wall welds. Patents or patents pending exist for all aspects of the unit.

3. **Established Government Pricing:** A negotiated price for GSA Advantage customers has been established by contract GS-07F-5769R, as amended by MO11, dated 5/20/05.

4. **Prior Government Procurements:**

- Department of Homeland Security - June 2005
- Washington Area Metro Transit Authority (WMATA) – June 2005
- Naval Research Laboratories – September 2005
- Amtrak –September 2005
- US Navy –Bahrain –September 2005
- Washington Area Metro Transit Authority (WMATA) December 2005 –reorder
- Amtrak –January 2006 – Re-order 204 MTR 101

5. **Responsive Delivery Schedule**: 60 days ARO – As reported in the GSA schedule. The vendor has also reported that drop shipments to various locations would be acceptable.

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APPENDIX C

POPULAR SCIENCE best of what's new

September 28, 2005

Mike Graff
Michael Gordon
BlastGard International

To Mr. Graff and Mr. Gordon;

I'm pleased to inform you that the BlastWrap has been chosen to receive a 2005 Best of What's New Award from ***POPULAR SCIENCE*** in the General Innovation category.

Each year, we review thousands of new products and innovations and choose the top 100 winners across 12 categories for inclusion in our annual Best of What's New issue, our best-read issue of the year. To win, a product or technology must represent a significant step forward in its category. All of the winners will be featured in this December's special editorial section, on newsstands November 15.

In the coming months, you will receive your Best of What's New statuette celebrating this achievement. **In the meantime, please withhold any public announcement about your selection until Wednesday, November 9.**

Congratulations!

Sincerely,

Mark Jannot
Editor

2 PARK AVENUE, 9TH FLOOR NEW YORK, NEW YORK 10016

APPENDIX D

DRAFT

A new way to stay safe

Kevin Sharpe, Blastgard International, Inc., USA, explains the importance of pipeline security and presents a new technology for minimising pipeline damage from terrorism.

There is a network of approximately one million miles of oil pipelines in the world. A network that safely and efficiently supplies us with a commodity that is fundamental to our modern way of life, a system as essential as electric and telephone wires. Pipelines transport fuel for cars, trucks, planes and ships, the energy needed for inexpensive shipment of our factory products and for our mobile lifestyle. Pipelines also deliver the crude oil that refineries convert into essential materials for core industries such as plastics, pharmaceuticals and agriculture. These are a vital part of the global infrastructure and economy.

These pipelines often originate or are routed through areas of economic and political instability and have for many years been the targets of acts of economic terrorism in long wars of attrition. As the world becomes more reliant on oil and the price continues to rise, it is realistic to expect these acts of sabotage to become more frequent and more costly.

The Association of Oil Pipe Lines in the US has said that it is continuing to take action to protect these vital liquid pipelines from terrorist attacks, and in cooperation, oil pipeline companies have greatly increased their security measures since the terrorist attacks on the

World Trade Centre in 2001. These security measures include increased surveillance of pipelines, employee background checks, restricted access to pipeline facilities and satellite surveillance systems, new guard patrols, increased training and more coordination with relevant agencies to correspond with each increasing threat level. Studies show that more than 95% of oil pipeline operators have implemented security plans and field audits are conducted to assess operator security preparedness. Even in perhaps the best prepared country in the world where the various bodies involved in these activities have a wealth of experience, vulnerabilities remain.

The energy supply chain in the US is decentralised, which reveals both its strength and weakness. One incident of sabotage at any point in this web is unlikely to have a substantial impact on the distribution system as a whole. The negative aspect of the system is that it is vulnerable to sustained or coordinated attacks. It's web-like nature renders total protection extremely difficult, and it is the explosiveness of the commodity in all forms that makes oil and gas infrastructure an attractive target. A devastating sabotage to this system would deal a psychological blow to the nation further inflamed by extensive media coverage.

Not all oil and gas transportation systems are as decentralised. Some countries route the majority of their fuel through a single pipeline, or choke point. These choke points are extremely vulnerable to sabotage and a single incident can produce significant negative economic effects.

There is some defense against the impact of this kind of economic terrorism. The oil industry prides itself on being able to rapidly repair damaged installations and return them to normal operations, but they clearly would struggle to meet the demands of sustained and organised terrorism aimed at vital elements of the energy system. Repair of individual oil line pipe sections is relatively straight forward, but attacks against pumping stations, valves, condensers, etc may be more difficult to overcome due to the limited availability of spares.

And it is these installations that are the very vulnerable portions of the system.

Oil and gas companies are reluctant to discuss their vulnerabilities or to say much about specific steps undertaken to accommodate a post 9/11 reality. Few want to underscore the reality that, outside of guns, gates and guards, physical options to protect the system are quite limited. The petroleum institute has pointed out that recent security measures do not incorporate new protective technology or designs but are instead, 'a new emphasis...a more systematic approach and a continuing re-evaluation' of individual company contingency plans in consultation with federal agencies. What is needed by these companies is a new technology that will integrate with existing security measures and offer meaningful protection against explosive sabotage.

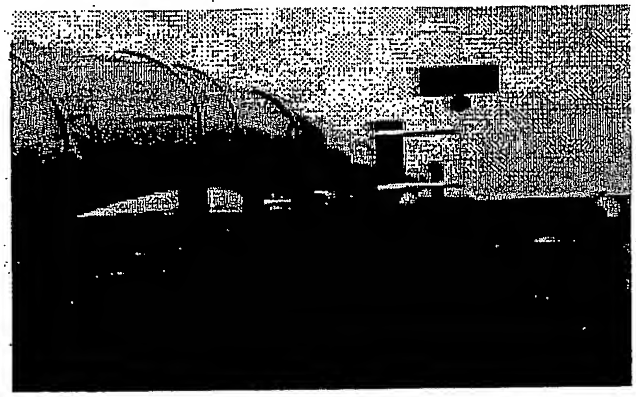

Figure 1. The Alyeska line.

Figure 2. Explosively formed hole in oil pipe.

Figure 3. Hydraulic shock damage to welded end caps.

Energy transportation infrastructure

The historical approach to security is detection and response, not deterrence or physical protection. Automated control systems will detect loss of pipeline pressure. Shutdown protocols are then activated to isolate the damaged area and repair teams are sent into the field; but, methods to protect the pipelines from such attacks are not in place.

Most oil and gas pipelines are routed underground, so in large part this historical approach may continue to work. Still, vital interconnections, compression, pigging or pumping stations are on the surface and are vulnerable. And there are large stretches of some pipelines that are routed above ground, like the Alyeska Line in Alaska (Figure 1).

Compressor stations to maintain pressure cost up to US$ 40 million each and are located approximately every 60 miles on a pipeline. Pipelines are easily and quickly repaired but if these compressor stations, for instance, were targeted, the pipeline would be shut down for an extended period until replacements could be found. A lot of damage can be wrought by a few pounds of plastic explosive.

Like pipelines, oil refineries are crucial to the global energy infrastructure and make an obvious terrorist target. Refineries are complex process units and might be viewed through some sinister eyes as time bombs waiting to go off. They make a most attractive target to terrorist organizations.

In many cases, little more than a padlock and chain-link fence separates a saboteur from these assets. Consequently, hardening these sites is a key and on-going task for pipeline owners. If these vital and valuable assets are to be protected, pipeline system nodes must be made more resistant to explosive devices. Materials technology is available, some of it transferred into the private sector from defense applications, but it has not yet been adopted by the oil and gas industry.

Infrastructure vulnerability

It is extremely easy to severely damage pipelines with explosives. An in-contact plastic explosive charge will cut through even a filled oil pipeline without difficulty. The massive detonation pressures (approximately 210 kbars) produced by the explosive charge produce a high pressure wave in the wall of the pipe which totally overmatches the strength of the steel, punching a hole through the pipe wall. This damage on its own is significant, but if the contents are under considerable pressure, cracks can form and rapidly propagate along the axis of the pipe. Further damage is caused by the explosively generated high pressure wave that propagates through the pipe into the oil, setting up a hydraulic shock, which can produce significant damage remote from the site of the explosion. An event such as this on the Kirkuk pipeline costs the Iraqi people US$ 7 million a day.

To assess the vulnerability of oil and gas pipelines to explosive attack, BlastGard International conducted a series of explosive tests at Bakersfield, CA. The tests graphically illustrate the phenomenon of high explosive breaching of oil pipelines and are described below.

The first test was conducted against a 24 in. OD steel line pipe with 3/8 in. wall thickness. The pipe had 3/8 in. thick caps welded on each end and the assembly was completely filled with water to replicate oil. A C4 uncased demolition charge was positioned against the side of the pipe and detonated. The charge punched a 6 in. diameter hole (Figure 2) through the side of the pipe allowing most of the contents to drain out.

The explosive blast had locally deformed the tube producing huge pressures and hydraulic shocks in the water filling the pipe. These pressures distorted the end caps and split the end welds (Figure 3).

Protection of pipelines

Guards, fences and other onsite observation systems are commonly employed pipeline protection methods. As a result, the probability of an early detection of pipeline damage may be increased; however, it takes only seconds to place an explosive device on a pipeline and then disappear, so it is unlikely this approach will prevent attacks of sabotage.

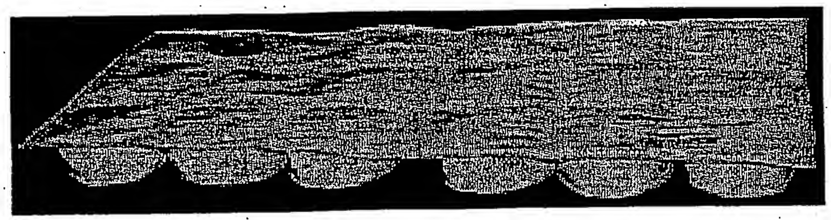
Figure 4. 3 in. thick BlastWrap™.

The current security measures can be made much more effective by the deployment of a passive protection system, such as BlastWrap™, to protect oil pipelines and other vulnerable assets such as pressure vessels, fuel bunkers, electrical power and substations. BlastWrap™ products are made from two flexible films filled with a shock attenuating filler material blended with a fire extinguishant. The material offers a revolutionary blast protection system against all blast and fire/burn threats. BlastWrap™ (Figure 4) not only substantially reduces blast impulse and pressure, but quenches fireballs and suppresses post-blast fires. BlastWrap™ dissipates substantial portions of blast energy through irreversible mechanical processes, and these results are accomplished passively, without dispersal of agents (foam or powder), without sensors and without the need for power.

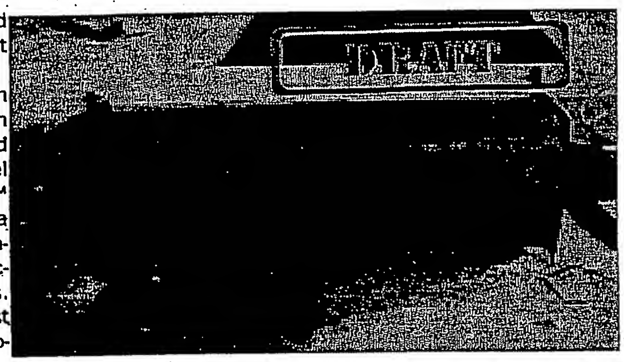
Figure 5. Slight indentation in pipe and no leakage.

As a demonstration of the protective power of BlastWrap™ the previous test was repeated except only a three inch thick layer of BlastWrap™ was used between an identical section of pipe and the C4 demolition charge. The charge did not penetrate the pipe or cause any leakage or remote damage (Figure 5).

Uncased demolition charges made from plastic explosive or nitroglycerin based commercial explosives like Dynamite are commonly used against oil and gas pipelines throughout he world. BlastWrap™, as demonstrated, works extremely well against this kind of threat.

Unfortunately, due to the availability of large quantities of military ordnance, the threat to pipelines in Iraq is much more severe.


Figure 6. Photo showing artillery shell placed on wellhead valve.

Figure 6 shows an unsophisticated improvised explosive device (IED) comprising a 122 or 130 mm artillery shell wired to mechanical timing device in this case a simple alarm clock.

This is a commonly used device in Iraq and this one was discovered in the Kabbaz Field, Northern Iraq. The IED has been attached to a 'Christmas tree' or well head. Note the plastic bottle filled with gasoline to enhance probability of well fire on detonation.The presence of fire makes repair even more costly and difficult. This simple device delivers a severe blast and fragmentation threat to a very valuable and difficult to repair target. BlastGard have been working to develop ways of protecting pipelines and oil installations against attack with IEDs consisting of fragmenting munitions. The protection system that has been developed to meet this threat consists of a light weight armor combined with BlastWrap™. It is important that a light weight armor is used rather than steel plate as steel is turned into highly damaging, high velocity fragmentation when driven by an in contact charge. The light weight armor does not contain Kevlar or any of the other difficult to obtain anti-ballistic fibres and the cost is similar to that of steel but is half the weight. The armor is applied to stop the fragmentation and the BlastWrap™ deals with the blast, shock holing and fireball threat. The combination is based on a system that has been developed to protect HMMWV military vehicles from IEDs that use the powerful 155mm artillery shell. This is an ideal and cost effective solution to the IED threat being applied in Iraq.

Summary

BlastWrap™ is the solution to explosive sabotage of oil pipelines. The unique blast mitigation capability is the missing link in the pipeline security systems. It offers protection against airblast and particularly the worst case scenario, in-contact charges and, in combination with a light weight armour, neutralises the threat from fragmenting munitions. BlastWrap™ can be rapidly retro-fitted to existing pipelines and is an inexpensive solution, especially in view of the costs of lost oil production and installation

repairs.

BlastWrap™ is an excellent thermal insulator and can be used to lag pipes. It is low density and adds little weight to a system. A single outer wrap material is required to ensure that the protective material is not easily identified by and/or removed by attackers. Commonly used aluminium sheet outer wrapping, that can be seen on the pipeline in Figure 1, is ideal.

BlastGard International Named 2005 Technology Innovation Award Winner by Aviation Week

Clearwater, Fl November __, 2005 – BlastGard International's, (OTCBB:BLGA), BlastWrap®" technology has been named a recipient of Aviation Week Magazine's 2005 Technology Innovation Award. BlastGard was one of only five recipients of the publications annual award highlighting innovation in aerospace and defense technology. The award will be presented at Aviation Week's conference taking place this week in Phoenix Arizona. This year's conference is focusing on the issues most critical to those working in Aviation where exploration, innovation, and invention meet head-on with the realities of national defense, transportation and security..

BastWrap® technology is a product that is designed to mitigate blasts and suppress blast thermal output and the ensuing fires from blasts and explosions, regardless of the material or compound that causes the explosion. BlastWrap® is configurable and consists of two flexible films arranged one over the other and joined together by a plurality of seams filled with volcanic glass beads and an extinguishant that offers a revolutionary protection system against blast and fire/burn threats. BlastWrap® can be wrapped around or conform to any shape, and it is being used in applications such as trash receptacles, oil pipelines, transportation vehicles etc.

"We are extremely proud that our BlastWrap® technology has been recognized by Aviation Week, a highly acclaimed industry trade publication. We believe that as BlastWrap® becomes known in the marketplace, it will revolutionize the way the world's governments and private industries deal with threats from explosive devices. BlastWrap® is designed to work in conjunction with different applications in a variety of market sectors to reduce the damage caused by explosions in a uniquely effective manner," said James Gordon CEO and founder of BlastGard International.

<u>**About BlastGard International, Inc.**</u>

BlastGard International, Inc. creates, designs, develops, manufactures and markets proprietary blast mitigation materials. The Company's patent-pending BlastWrap® technology effectively mitigates blast effects and suppresses post-blast fires. This unique technology can be used to create new, finished products or be used to retrofit to existing products. While the need for this technology has always been present, the security and safety concerns resulting from the September 11, 2001 acts and the subsequent development of Homeland Security make the timing of the Company's emergence even more important. The Company's core market focus is on blast effects mitigation for the commercial sector, military, law enforcement and government agencies. BlastWrap® is based upon well-defined principles and suppresses blast pressures by 50% or more. BlastWrap® products are made from two flexible films arranged one over the other and joined by a

plurality of seams filled with attenuating filler material (volcanic glass bead or other suitable two-phase materials), configurable (designed for each application) with an extinguishing coating that offers a revolutionary blast protection system against Blast & Fire/burn threats. BlastWrap® is a blast mitigation assembly that can be wrapped around or conform to any shape. BlastWrap® is a concept (not a chemical compound) from which blast protection products are built to save lives and reduce damage to valuable assets from explosions. Additional information on BlastGard can be found at http://www.blastgardintl.com.

"Safe Harbor" statement under the Private Securities Litigation Reform Act of 1995: Except for historical information, all of the statements, expectations and assumptions contained in the foregoing are forward-looking statements that involve a number of risks and uncertainties. It is possible that the assumptions made by management are not necessarily the most likely and may not materialize. In addition, other important factors that could cause actual results to differ materially include the following: the Company's ability to market its products; the Company's ability to obtain additional funding; the Company's ability to obtain regulatory approvals on new products, the general economy; competitive factors; ability to attract and retain personnel; the price of the Company's stock; and other risk factors. The Company takes no obligation to update or correct forward-looking statements.

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Discussion of the Effects of Blast Overpressure on the Human Body
With Reference to Explosion Resistant Trash Receptacles

Kevin J Sharpe

BlastGard International, Inc.

Executive Summary

Increasingly spectacular statements are being made by several manufacturers of blast resistant trash receptacles where it is claimed that their products can protect against explosive threats. Threats as large as 10lbs (4.54Kgs) of high explosive, and such claims are becoming commonplace. These claims are misleading and place the public at significant risk in the event of an explosion. What the claims actually refer to is that the blast resistant bin **doesn't come apart, or fragment** under the explosive loading from a large (usually centrally placed) internal detonation. Protecting against an explosive event of this magnitude is a far more challenging task than merely ensuring that the receptacle remains intact.

If a trash receptacle is to offer comprehensive protection from an explosion to the public the following four threats have to be addressed:

- Primary fragmentation from material in contact with the explosive (like a pipe bomb)
- Secondary fragmentation from material close to the explosive (usually the bin itself)
- Blast pressure
- Thermal/Fireball

This discussion examines the threats posed to the public from explosions within trash receptacles and offers insight into the physiological damage that such an event may cause to the human body.

There are currently no guidelines available in the US for manufacturers of **blast resistant trash receptacles** (trash receptacles that dramatically reduce the hazardous effects to the public from an internal explosion) and there are no accepted standards for testing or certification. This note proposes that this may be an opportune moment for the discussion on standards, testing and certification to begin. An attempt at defining such a standard is included.

Introduction

The problem in dealing with all four of the threats has been approached by BlastGard International, Inc. and its partner, Centerpoint Manufacturing, Inc. from two perspectives; the first is an awareness of the practicalities of developing a trash receptacle that can withstand the detonation of a large explosive charge and the second is a development of a technology that can dramatically reduce the threat to the public from the threats from blast pressure and thermal/fireball. BlastGard International's product BlastWrap™ has been developed specifically to extinguish the fireball in a few milliseconds and to dramatically reduce blast pressures. The experience and expertise to evaluate the effects of these phenomena on the human body and also on structures is essential if the

implications are to be understood.

My background is in explosive engineering, the measurement and mitigation of blast in improvised explosive device (IED) disposal scenarios and the evaluation of vulnerabilities in structures and systems. I worked for the UK Ministry of Defence for over 24 years, until recently when I joined the BlastGard International team.

The Threat

Correct identification of the threats that a system has to survive is crucial to the successful design of an effective solution. A clear understanding of what is required of a system is also crucial. If a proposed solution to a threat concentrates in just one area ignoring the other more challenging threats, then the solution will be ineffective.

The most common terrorist threats, as seen through out the world, have been:

- Steel pipe bomb filled with ½ lb of smokeless powder.
- Small TNT bare charges.
- Nut, bolt and nail-laden explosives charges.

This experience has been rudely shaken by recent events on the underground rail system in London. It can be seen that terrorists are planning to kill and maim large numbers of people and are using increasingly large explosive charges. The charge sizes used in the London bombings has been estimated to be around 10lbs of TNT equivalence.

It is relatively easy and inconspicuous to drop a small package containing an IED into a trash receptacle. Upon detonation, an "unhardened" trash receptacle becomes part of the threat by fragmenting into many potentially lethal pieces, much like a grenade.

However, a ten pound high explosive charge is not so easily deposited. If formed into a sphere, it would have a diameter of seven inches and when combined with a timing and power unit (TPU), shrapnel and packaging, it would be relatively bulky (in fact the devices used in London were carried and deployed in backpacks). Depositing such a bulky package into a litterbin is an unusual act and may draw attention but is not beyond what is possible and so we regard the maximum credible charge size that may be placed in a trash receptacle as being ten pounds TNT equivalent or less.

Managing the Threat

There are four distinct aspects of an IED explosion inside a trash receptacle that need to be managed effectively if members of the public in the surrounding area

are to avoid injury. These are:

- Primary fragmentation from the casing of the device or materials in contact with the explosive charge.
- Secondary fragmentation from the break up of the trash receptacle under explosive loading, or from the acceleration of adjacent articles in the trash receptacle
- Air blast pressure
- Thermal/fireball effects

Any blast resistant trash receptacle must stop the primary fragmentation from escaping as this is the most immediate and potentially lethal threat to the public. The bin also must not come apart under explosive loading, potentially generating secondary fragmentation and adding to the lethality of the device. In addition to these two criteria, it is essential that the air blast pressure, blast flash and thermal/fireball output are effectively managed. Each one of these can be as damaging or lethal as is fragmentation. **A bin that is designed merely to not come apart, but that does not mitigate the explosion, will funnel the blast and fireball out of the open end much like a cannon. This focusing effect can have catastrophic consequences for people, buildings and structures.** To illustrate the fact that blast must be managed if the threat to life and limb is to be reduced as far as is possible, the following paragraphs describe the effects of blast on the human body.

Patho-physiology of Blast Injuries

Traditionally, blast injuries are divided into four categories: primary, secondary, tertiary, and miscellaneous injuries. A patient may be injured by more than one of these mechanisms.

- A primary blast injury is caused solely by the direct effect of blast overpressure on tissue. Air is easily compressible, unlike water. As a result, a primary blast injury almost always affects air-filled structures such as the lung, ear, and gastrointestinal (GI) tract.
- A secondary blast injury is caused by flying objects that strike people.
- A tertiary blast injury is a feature of high-energy explosions. This type of injury occurs when people fly through the air and strike other objects.
- Miscellaneous blast-related injuries encompass all other injuries caused by explosions. For example, the collision of two jet airplanes into the World Trade Center created a relatively low-order pressure wave, but the resulting fire and building collapse killed thousands.

The patient's location relative to the center of an explosion is a critical factor in determining the extent and severity of the injuries sustained.

- An explosion that occurs in an enclosed space (including a building, mine, or a relatively lightly constructed enclosed space such as a bus) or in water tends to cause more serious injury.
- Intensity of an explosion's pressure wave declines with the cubed root of the distance from the explosion. A person 3 m (10 ft) from an explosion experiences 9 times more overpressure than a person 6 m (20 ft) away. Proximity of the person to the explosion is an important factor in a primary blast injury.
- Blast waves are reflected by solid surfaces; thus, a person standing next to a wall or in a corner will likely suffer significantly increased primary blast injury. Reflected blast pressures can be as much as 8 times the intensity of the original. Explosions inside buildings and others structures can produce highly complex and unpredictable blast hazards.

The primary causes of blast injury are as follows:

- The direct effect of blast overpressure on tissue. Since air is easily compressible by pressure while water is not, this overpressure almost always affects air-filled structures.
- Pulmonary barotrauma (damage to the lungs caused by pressure) which is the most common fatal primary blast injury. This includes pulmonary contusion, systemic air embolism, and free radical–associated injuries such as thrombosis, lipoxygenation, and disseminated intravascular coagulation (DIC). Acute Respiratory Distress Syndrome (ARDS) may be a result of direct lung injury or of shock from other body injuries.
- Acute gas embolism (AGE), a form of pulmonary barotrauma, requires special attention. Air emboli most commonly occlude blood vessels in the brain or spinal cord. Resulting neurological symptoms must be differentiated from the direct effect of trauma.
- Intestinal barotrauma is more common in underwater explosions than in air blasts. Although the colon usually is affected most, any portion of the GI tract may be injured.
- The ear is the organ most susceptible to primary air blast injury. Acoustic barotrauma commonly consists of tympanic membrane (TM) rupture, or burst eardrum. Hemotympanum (bleeding of the eardrum) without perforation also

has been reported. Ossicle fracture (of a small bone in the inner ear) or dislocation may occur with very high-energy explosions.

The secondary causes of blast injury are:

- Injuries caused by flying objects striking individuals.
- These secondary mechanisms are responsible for the majority of casualties in many explosions. For example, the glass facade of the Alfred P. Murrah Federal Building in Oklahoma City shattered into thousands of heavy glass chunks that were propelled through occupied areas of the building with devastating results.
- Military explosive casings (e.g. hand grenades) are specifically designed to fragment and to maximize damage from flying debris (shrapnel).
- Civilian terrorist bombers (e.g. Olympic Park in Atlanta) often deliberately place screws or other small metal objects around their weapons to increase secondary blast injuries.

The tertiary causes of blast injury

- These injuries are caused by individuals flying through the air and striking other objects, generally from high-energy explosions.
- Unless the explosion is of extremely high energy or focused in some way (e.g. through a door or hatch), a person with tertiary blast injury usually is very close to the explosion source.
- Together with secondary blast injuries, this category accounted for most of the pediatric casualties in Oklahoma City. There was a high incidence of skull fractures (including 17 children with open brain injuries) and long-bone injuries including traumatic amputations.

Miscellaneous blast-related injuries (other injuries generated by the explosion) are caused by the following:

- Toxic inhalations and exposures, radiation exposure, burns (chemical or thermal)
- Asphyxiation in fires (including carbon monoxide [CO] and cyanide [CN] poisoning following incomplete combustion), and dust inhalation, including coal and asbestos exposure
- Crush injuries from collapsed structures and displaced heavy objects

Mortality/Morbidity

- Mortality rates vary widely. Injury is caused both by direct blast overpressure (primary blast injury) and by a variety of associated factors.
- Mortality is increased when explosions occur in closed or confined spaces (e.g. terrorist bus bombings) or under water. Land mine injuries are associated with a high risk of below- and above-the-knee amputations. Fireworks-related injuries prompt an estimated 10,000-12,000 ER visits in the United States annually, with 20-25% involving either the eye or hand.
- Presence of tympanic membrane (TM) rupture indicates that a high-pressure wave (at least 6 psi or 40 kPa) was present and may correlate with more dangerous organ injury. Theoretically, at an overpressure of 15 psi or 100 kPa (the threshold for lung injury, TM routinely ruptures; however, a recent Israeli case series of 640 civilian victims of terrorist bombings contradicts traditional beliefs about a clear correlation between the presence of TM injury and coincident organ damage. Of 137 patients initially diagnosed as having isolated eardrum perforation who were well enough to be discharged, none later developed manifestations of pulmonary or intestinal blast injury. Furthermore, 18 patients with pulmonary blast injuries had no eardrum perforation.

Blast Injury Threshold

The case of ten pounds (4.54Kg) of TNT equivalence detonated inside a litter bin is now considered. Ten pounds of TNT liberates on detonation around 19 million Joules (MJ) of energy. This is a huge amount of energy to dissipate in a few thousandths of a second. Some blast resistant trash receptacle manufacturers claim that energy is taken out of the blast by the deformation of the receptacle. Simple calculation shows that deformation of the steel bin will only account for a tiny portion of the 19 MJ available. The remainder of the energy will either be transmitted through the sides as a shock or vented out through the open end. It is misleading, as some manufacturers suggest, that the blast is "directed up away from the people, and not outwards". **This is plainly not true.** While the blast is initially focussed upwards out of the open mouth of the bin, the pressure wave will expand to equalize the pressure on either side of the shock wave and begin to spread outwards spherically immediately upon exiting the bin. On impacting with the ground surrounding the receptacle the blast wave will be reflected from the surface and ***it will establish itself as a stable, hemispherical blast wave, very similar to that generated by a 10lb charge detonated in free air.*** Tests conducted at Bakersfield, California have shown exactly this. The reduction in blast pressure by detonation of the charge inside an unmitigated trash receptacle is minimal.

As shown in the tests for a charge as large as 10lbs, the effects of the bin will be negligible on the overpressure developed. Scaling of the 10lb charge gives the

following estimations of pressures and physiological impact on the human body:

Distance from Bin	Injury to 70Kg Human
9 feet	Severe burns
17 feet	Onset of lung damage
18 feet	First degree burns
28 feet	All eardrums burst
43 feet	Onset eardrum rupture
98 feet	Completely safe

It should be noted that these figures are for <u>free field</u> hemispherical blasts. The possibility of injury will be significantly increased where there are complex reflections, as in the case of an explosion inside a building. The data given in the table above has been assembled from a number of different sources notably Paul Coopers "Explosive Engineering" and from the graph shown below obtained from the Journal of Mine Action website (http://maic.jmu.edu/journal/4.2/Focus/Bass/bass.htm).

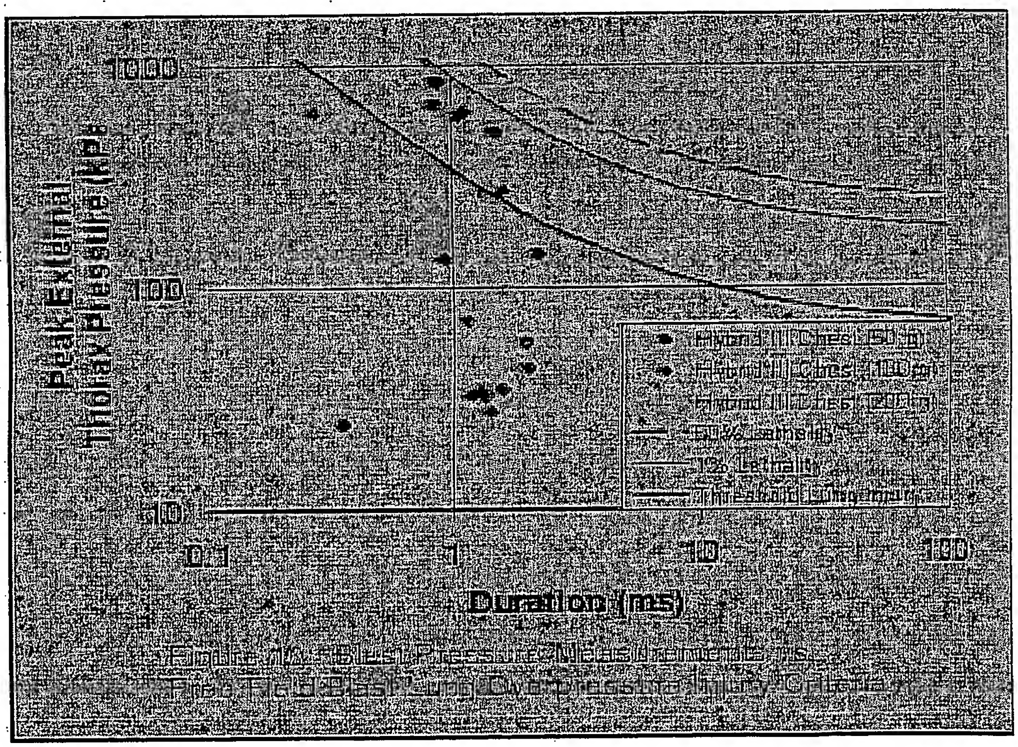

Fig 1: Pressure/duration data for the onset of blast injury

It can be seen from the data in the table that if substantial mitigation of the blast is not provided, an important part of the threat from an IED detonated internally in a trash receptacle will not be managed effectively. The following photographs give an indication of the kind of crowded environments in which trash receptacles are normally deployed. It is instructive to consider the data on blast injury given above when referring to the photos.

Fig 2: Airport concourse “sterile” area.

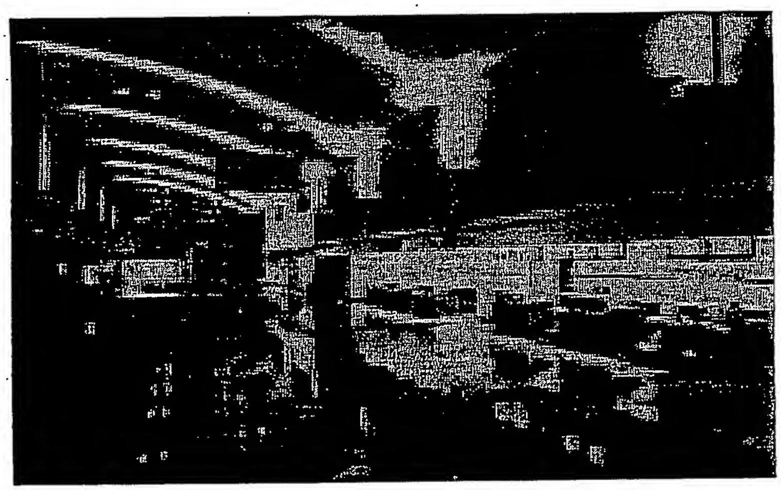

Fig 3: Airport concourse “non sterile” area

Fig 4: Subway platform

Trash receptacles are deployed in areas of high footfall, often inside structures, where the blast environment is complex and multiple reflections will form. This is likely the worst in-air scenario for blast injuries.

The answer to the conundrum of blast resistant trash receptacle placement may lie in the choice of charge size, against which the public can be claimed to be safely protected. Charge sizes of 10lb are simply not manageable in scenarios where people regularly approach within a few feet of the target bin unless the blast and fireball are dramatically reduced. The following table considers the implications for reducing the charge size on blast overpressure and fireball in relation to human physiological injury:

For 6lbs TNT

Distance from Bin	Injury to 70Kg Human
7.4 feet	Severe burns
14.5 feet	Onset of lung damage
15 feet	First degree burns
24 feet	All eardrums burst
36 feet	Onset eardrum rupture
83 feet	Completely safe

For 3lbs TNT

Distance from Bin	Injury to 70Kg Human
6.3 feet	Severe burns
11 feet	Onset of lung damage
12 feet	First degree burns
19 feet	All eardrums burst
29 feet	Onset eardrum rupture
65 feet	Completely safe

For 1lb TNT

Distance from Bin	Injury to 70Kg Human
5 feet	Severe burns
8 feet	Onset of lung damage
10 feet	First degree burns
13 feet	All eardrums burst
20 feet	Onset eardrum rupture
46 feet	Completely safe

It can be seen that if the charge size is lowered to 3lb the damaging blast radius is reduced, but not significantly; and, the risk of serious injury still remains. What is significant is the reduction in blast pressures inside the trash receptacle. The opportunity for energy absorption by plastic deformation of the receptacle wall and blast mitigation applied internally to mitigate the blast pressure is dramatically improved. Ultimately, the effectiveness of this approach can only be quantified by testing and evaluation.

Structural damage from an internal blast is also a significant issue that must be addressed. The top of a litter bin in the top photograph of Fig 2 would be approximately 8 feet (2.46m) from the ceiling. For a 10lb charge the roof structure will experience significantly more than 380 psi reflected blast pressure. And this does not take into account the significant blast focusing effect of the receptacle. Pressures of this magnitude are certainly capable of destroying main structural members and causing catastrophic failure of the entire structure. As discussed in much of the literature on blast, the majority of fatalities are not caused by the direct effects of the blast wave on the human body but by the catastrophic failure of the structure that the victims occupy or by the violent translation caused to them. This was tragically illustrated by the bombing of Alfred P Murrah Building in Oklahoma City.

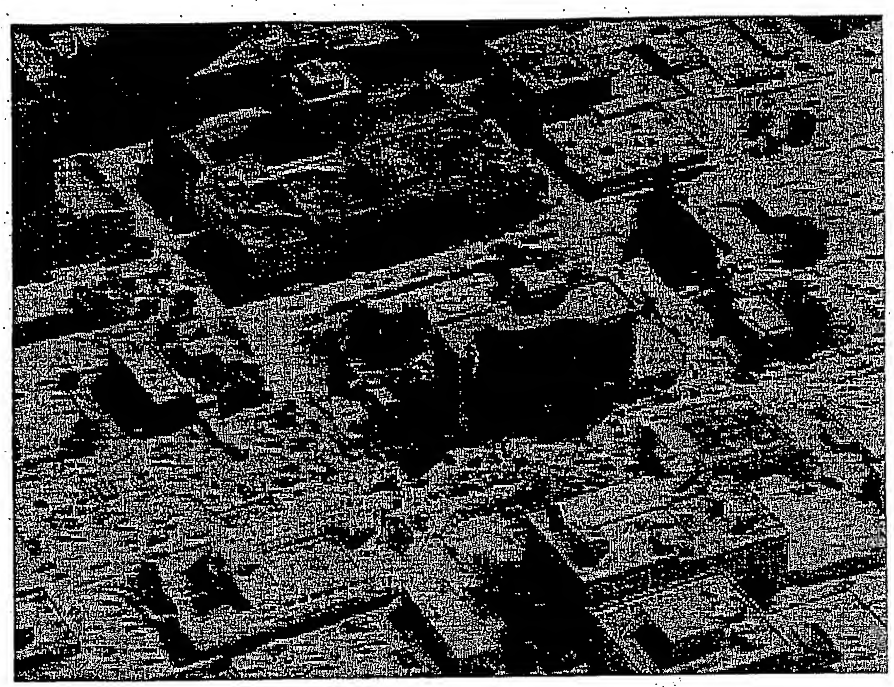

Fig 5: Aerial picture showing blast and structural damage to the Alfred P Murrah building, Oklahoma City.

Without going into detail in this note, it is worth pointing out that many buildings are extremely vulnerable to blast, and that catastrophic failure can result from a relatively minor explosive event. Blast must be managed if one is serious about saving lives in the event of an explosive attack.

Blast Management

So, what can be done? There are three accepted methods of effectively managing internal explosive blasts: total containment, controlled venting and blast mitigation.

With a total containment system the explosion would be contained within an extremely strong sealed system usually a steel cylinder or sphere fitted with a blast proof door. This kind of system is associated with a significant cost and mass penalty and as they will have to be closed to be effective, so they are of effectively no use as a trash receptacle.

Controlled venting utilizes the strong containment approach but manages the quasi-static pressure within the container by venting the highly pressurized hot gases/fireball out through vents of a carefully designed type and size. This system has mass cost issues, and the vent size is unlikely to be appropriate for use as a trash receptacle.

Blast mitigation is an effective approach. Blast mitigants such as BlastWrap™ have been shown to reduce blast overpressure by as much as 97% with distance, and they are regularly used in reducing the effects of explosions. Testing has shown that, even for massive charges, BlastWrap™ reduces the blast pressure around the trash receptacle by more than 80% (85% for the MTR101 as measured during recent testing).

The driving factor in the development of a trash receptacle that can protect the public from the devastating effects of a terrorist bomb is not only whether the receptacle stays together under explosive loading but how the blast and fireball can be reduced to levels that are no longer a significant threat.

One further point on receptacle design: it is essential that in the event of the trash receptacle failing, that it fails in a safe mode. "Safe", in this case, means splitting down one side under excessive loading, but not fragmenting.

National Standards

Unfortunately, there are currently no official (US) standards with which vendors can comply when developing blast resistant trash receptacles. There are also no restrictions upon or guidelines for buyers when purchasing these products. These facts make it most important for buyers and sellers to exercise carefully considered judgments when purchasing and deploying these products.

Blast resistant trash receptacle manufacturers need to take these matters to heart. There are, however, standards that exist in other countries that define the method and threat for testing explosive proof bins (notably "Specification for Explosive Testing of Litter Bins" by Dr R. Lacey and M. J. Pettit of the UK Police Scientific Development Bureau). To obtain this report, access the Home Office website at:

http://www.homeoffice.gov.uk/crimpol/police/scidev/publications.html

The standard threat suggested within this note is a plastic explosive charge surrounded by various common trash items and steel balls to represent "worse case" fragmentation. The mass of the charge is defined by the trash receptacle manufacturer and indicates the charge size for which the unit is capable. For the US it is suggested that a 10lb (4.54Kg) bare charge of TNT, and a steel pipe bomb filled with 0.55lb (250g) smokeless powder represent credible test threats, since these are threats commonly seen throughout the world.

Now there is a unique opportunity to develop a thorough and credible specification for testing blast resistant trash receptacles. Importantly, it is also an excellent opportunity to challenge some of the dangerous claims that are being made in this field.

A beginning for this effort may look something like this:

"A blast resistant trash receptacle must be able to withstand an internal blast from a 10lb bare TNT charge detonated in three positions within the receptacle; center, sidewall (at the internal weld seam) and bottom. The bin must remain intact, and must produce no secondary fragmentation. It must not, in any way, increase the hazard from the explosive device. The bin must stop all of the primary fragmentation from a steel pipe bomb filled with 250g of smokeless powder or a standard military issue hand grenade (whichever is found to be the more severe threat). Blast pressures must be lower than potentially lethal beyond five feet from the edge of the bin. Flash and fireball must be extinguished within a few milliseconds." On this last point about thermal effects, we are of the opinion that a dramatically shortened "live fireball" will substantially reduce or eliminate the possibility of human skin burns below the 2 cal/cc^2, the point beyond which burns are no longer avoidable. Further testing to confirm this opinion will ensue.

References

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2. "Journal of Hazardous Materials", Vol 52-No.1, January 1997. ISSN 0304 3894.
3. Eric Lavonas, MD, FACEP, Department of Emergency Medicine, Divisions of Toxicology and Hyperbaric Medicine. Carolinas Medical Centre.

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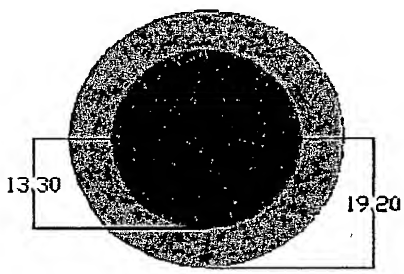
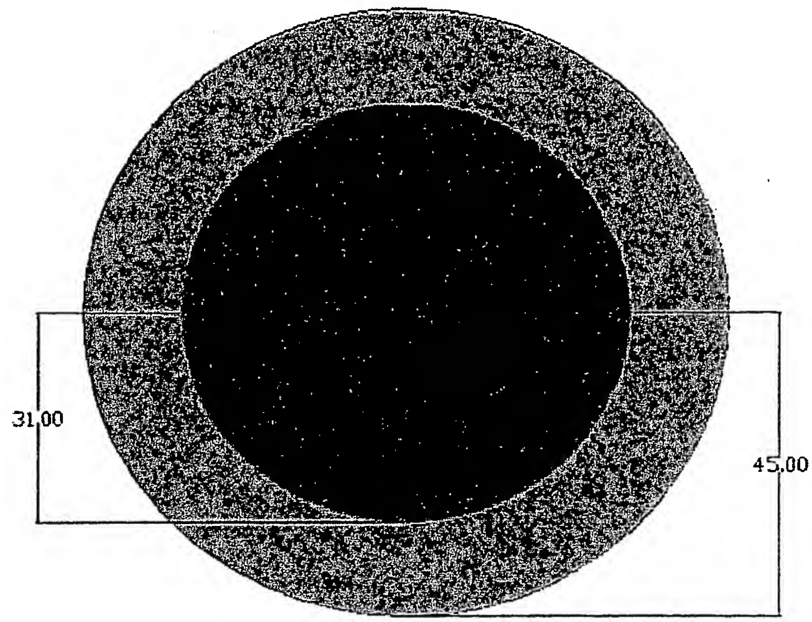
The "Circles of Injury"

UNMITIGATED

Onset Lung Damage -
4 Lb. & 12 Lb. C4 Charge

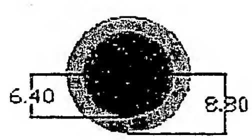


Onset Ear Damage -
4 Lb. & 12 Lb. C4 Charg

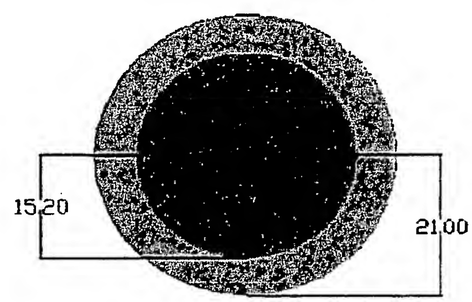


BlastWrap-Mitigated

Onset Lung Damage -
4 Lb. & 12 Lb. C4 Charge



Onset Ear Damage -
4 Lb. & 12 Lb. C4 Charg



Thermal Injuries
And Prevention/Mitigation Measures

A summary of observations and interviews from OEF and OIF

27 October 2005

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Table of Contents

Prologue

The observations, analyses and assessments summarized in this document are based on the candid comments and reports of the men and women who fought the battles, supported the forces, and led our Marines. The high level of professionalism and military aptitude demonstrated by individual and unit performances during OIF/OEF were a hallmark of these conflicts. The Marine Corps has an enviable reputation for innovation and adaptation, and maintains the highest standards of excellence in the art of warfare. It is with a conscious intent to maintain this reputation that the Marine Corps Center for Lessons Learned offers the observations and commentary within this report.

Comments and feedback are welcome and encouraged. It is recognized that what works in one area of operations (AO) may not be effective in another AO or conflict. Just as the enemy changes their TTPs, we too must quickly change and adapt to the fight at hand. Please take the information provided, build on it, and report back on its applicability. It is of the utmost importance that individuals and units continue to provide their lessons and observations so we can ensure the next unit to deploy has your documented hard earned experience prior to crossing the line of departure. Getting your observations and lessons into the Lesson Management System early enough to impact pre-deployment training is crucial to increasing the effectiveness of follow on units and saving the lives of our Marines.

This is one of many documents and briefings covering a wide variety of topics that have been put together by the Marine Corps Center for Lessons Learned. These collations of lessons and observations are not sole source or authoritative, but are intended as a means of informing the decision making process and effecting needed changes in our institution.

M E Dunard

M. E. Dunard
Colonel, United States Marine Corps Reserve
Director, Marine Corps Center for Lessons Learned

Tasking

The Marine Corps Center for Lesson Learned produced this report in order to promulgate facts related to burn injuries sustained during Operation Enduring Freedom and Operation Iraqi Freedom and to identify promising alternatives for preventing and/or mitigating future incidents. This is the result of initial observations of trends in burn injuries in the Iraqi theater that led to further research for factual data upon which to base an informed decision.

Overview

This document is based upon vetted input from Operating Forces submitted to the MCCLL Lessons Management System (LMS) and observations and information gathered by forward deployed collectors from the MCCLL. While the information contained within the LMS provides insight into the area of interest, it may not represent a comprehensive overview of the issues. In some cases, there may be perspectives not available within the MCCLL database. Circumstances and the operating environment that existed for any particular observation may not apply in other regions or even other locations within an Area of Operation (AO). Sound military judgment has been applied in vetting these lessons for inclusion in the LMS and in this report.

Information presented below provides a summary of the data currently contained within the LMS on the topic. Source material for this document is contained in an LMS binder located at **www.mccll.usmc.mil**. After registration/login, click on "My Binders", then "Thermal Injuries". Information on other topics is available in the Marine Corps Lessons Management System (LMS) at:

NIPRNET: www.mccll.usmc.mil
SIPRNET: www.mccll.usmc.smil.mil

Background

The Marine Corps Center for Lessons Learned is grateful for the professional, collaborative support from the Joint Center for Operational Analysis, Brooke Army Medical Center, the Headquarters US Army Medical Department Office of Policy and Services, the Department of Emergency Medicine at Naval Medical Center Portsmouth, and the Naval Health Research Center.

Executive Summary

> *"...he suddenly felt the vehicle lurch upwards. He said that he saw a bright flash and felt a sudden burst of heat.*
>
> *He went on to say that the Marines were able to exit the AAV, provide security and provide medical attention to those who required it. He credited his "Wiley-X" goggles with saving his eyes and his "nomex flight gloves" with saving his hands from burns.*
>
> *The 1stLt. sustained flash burns to his forearms and his face. These areas on his body were the only areas that were not covered by protective gear or MARPAT uniform."*
>
> \- Lesson ID 7792, Marine Corps Center for Lessons Learned
> www.mccll.usmc.mil

II Marine Expeditionary Force (MEF) data collected from 27 March 2005 to 23 October 2005 indicate that thermal injuries accounted for roughly 5% of Marine injuries and fatalities.[1] Improvised Explosive Devices (IEDs) are believed to be the cause of 54% of injuries overall and the cause of 43% of thermal injuries. Thermal injuries accounted for roughly 4% of II MEF killed in action (KIAs) and 10% of II MEF personnel evacuated from theater. Thermal injuries are occurring at nearly twice the rate of thermal injuries in OIF I.[2]

Naval Health Research Center (NHRC) data indicate roughly 65% of Navy/Marine combat thermal injuries from May-August 2005 involved vehicle operations.[3] Roughly 80% of Navy/Marine combat thermal injuries were to hands, head, or neck. Notably, there were comparatively few thermal injuries to torso areas typically covered by body armor. See Figure 1.

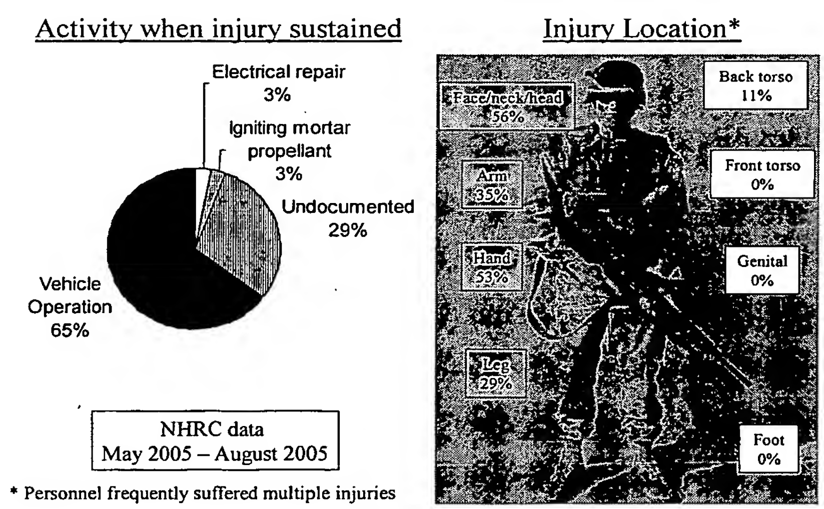

Figure 1: Navy/Marine burn injuries, May-August 2005

Although 62% of II MEF personnel suffering thermal injuries were classified as "Not seriously injured", roughly 50% of all thermally injured personnel were evacuated for treatment or removed from duty for a week or more. This reflects adherence to American Burn Association recommendations that patients with even small, isolated burns to the hand or face be transferred to a burn center for treatment.

II MEF and NHRC data correlate with thermal injury data from an earlier period of time. Doctors at the US Army Institute of Surgical Research (USAISR) conducted research on the nature of injury and treatment results from thermal injury patients treated at Brooke Army Medical center between 5 April 2003 and 23 April 2005.[4] USAISR research concluded that increased enemy use of improvised explosive devices (IEDs) was causing an increase in thermal injuries and fatalities. USAISR concluded increased use of fire retardant personal protective equipment (PPE) could lessen the incidence rate of thermal injury and lessen the severity of injuries sustained (see attached report). Concurrently, doctors at the Department of Emergency Medicine at Naval Medical Center Portsmouth conducted research that arrived at similar findings and conclusions.[5] Deployed Marines have noticed the trends, as noted in the below quotes.

> *"Underarmor and Polypro is good gear until it shrink wraps (melts) to your body or catches on fire and burns like plastic/polymers can. MT drivers, EOD, Engrs, and MPs (basically anyone outside the wire in convoys etc.) need to be issued Nomex Suits, hoods, and gloves. The Marine Corps needs to look at fire retardant uniforms and under garments in the future to reduce burn/blast injuries."*
>
> - **Comment recorded during Marine Corps Center for Lessons Learned CSSE Commanders Lesson Learned Conference, 15-17 May 2005.**

> *"Several NCOs reported instances of being set afire during breaching operations and recommended that fire retardant clothing, particularly tee shirts and some sort of face guard, be procured for combat operations. Similarly, they expressed a need for some sort of fire retardant neck protection. They proposed several solutions, such as aviation flight suit material (Nomex) or equipment as used by firefighters or racecar drivers."*
>
> *"They would also like to see some sort of standard issue glove, such as those used by aircrew or mechanics. They reported that the gloves currently issued to combat vehicle crewmen were inadequate and rarely used. For cold weather operations, they proposed Nomex material covered by some kind of insulator to provide warmth."*
>
> - **Excerpts from Marine Corps Center for Lessons Learned Report on Non-Commissioned Officers Lessons Learned Conference, 9-10 August 2005**

Possible prevention and mitigation measures for thermal injuries include:

1) Tactics, Techniques, Procedures – To address the burn injury threat where it is highest – vehicle movements – units might consider SOPs requiring passenger and crew members to minimize exposed skin while in transit. Mission conditions permitting, passengers might also consider wearing fire retardant gloves and hoods, if available. Similarly, units might consider mandatory usage of fire retardant equipment by vehicle crew members, if such equipment is available. This type of practice is common in the aviation community during helicopter operations, where passengers must wear cranial protection or a helmet prior to entering the aircraft. Aircraft commanders and crew members ensure the personal protective equipment (PPE) is worn, and they also collect the PPE for storage in a common equipment pool between usage.

2) Material – As a temporary near term solution, units may procure equipment for those personnel deemed most at risk for burn injuries:[6]

    - Nomex jumpers and suits range in price from $65-$200.
    - Fire-retardant gloves cost roughly $21 per pair.
    - Nomex balaclava costs range from $20-$33.

    Before making a large-scale procurement, units should first conduct limited trials to determine how this PPE affects usage of other individual equipment (e.g., helmets) and whether this additional equipment causes excessive degradation in task performance.

    The Marine Corps Safety Center Ground Safety Division has tested sniper "ghillie" suits treated with commercial fire retardant chemicals, observing favorable initial results. However further research is required to ensure use of the chemicals on clothing does not lead to adverse health effects.[7]

3) Training – Usage of PPE frequently requires training in order to increase task proficiency to overcome decreased mobility or sense of touch. Loss of touch and increased personal discomfort are common excuses for not wearing PPE if an individual possesses the equipment.

    Continued training on counter-IED measures can contribute to a reduction in IED incidents – the leading cause of thermal injuries.

4) Leadership and education – Leaders may be unaware of the prevalence or effects of thermal injuries. Command awareness and dissemination of thermal injury information may increase use of available PPE and adherence to safety procedures.

Program managers at Marine Corps Systems Command (SYSCOM) are aware of the thermal injury data and are researching material solutions. However, they do not currently have a universal needs statement (UNS) or Urgent UNS directly related to prevention of thermal injuries to validate the need for expedited fielding of additional equipment to Marines.[8] Fire retardant properties are included in most uniform item specifications. For example, Urgent UNS

05048UA *OIF-III - Under Body Armor Cooling Shirt* identifies a need for "a fire retardant moisture-wicking shirt".

Conclusion

The prevalence and consequences of thermal injury are well-documented in research papers, deployed II MEF classified websites, and various briefings circulating stateside. Dissemination of this information to unit commanders, educators, and trainers can lead to better awareness – the first step in injury prevention. Units have a variety of options they may pursue for reducing the threat of thermal injury. Marine Corps material solution developers have thermal injury data but lack formal documentation of the need for increased thermal injury prevention measures. Documentation of the need is required to pursue a Corps-wide material solution.

Recommendations:

1) Unit leaders should continue to emphasize IED countermeasures.
2) Unit leaders and Marine training/education commands should disseminate USAISR thermal injury research and promote the use of PPE for preventing thermal injury and preserving combat capability.
3) MEFs and material solution developers should continue their collaboration to define the requirement and urgency for thermal injury prevention/mitigation material solutions.
4) Commands should encourage personnel to use of Marine Corps Center for Lesson Learned Lesson Management System, Operational Medicine web forum, and Rifleman Suite web forum for sharing insights related to burn prevention and mitigation measures.

Attachment 1: Commander, United States Army Institute of Surgical Research letter, *Protection against Hand Burns,* 24 October 2005.

Attachment 2: United States Army Institute of Surgical Research Paper, *Analysis of thermal injuries sustained during vehicular maneuvers in Operations Iraqi and Enduring Freedom*

Protection Against Hand Burns

DEPARTMENT OF THE ARMY
U.S. ARMY INSTITUTE OF SURGICAL RESEARCH
3400 RAWLEY E. CHAMBERS AVENUE, BLDG 3611
FORT SAM HOUSTON, TEXAS 78234-6315

REPLY TO ATTENTION OF

Office of the Commander 24 October 2005

Colonel Monte E. Dunard
Director - Marine Corps Center for Lessons Learned
TECOM, Marine Corps Combat Development Command
3300 Russell Road
Quantico, VA 22134-5001

Subject: Protection Against Hand Burns

Colonel Dunard,

As you know the US Army Institute of Surgical Research Burn Center admits all seriously burned casualties from OEF/OIF. Since April 2003, we have admitted 344 OIF/OEF admissions, 268 (78%) with hand burns. During that time 86 Marines have been admitted, 60 with serious hand burns. Of those, 36% (22) Marines sustained injuries which will likely preclude their continued military service and result in long term disability. Practically all of the Marines reported not wearing any type of protective gloves at the time of their injury. We have just initiated a call back to each Marine, intending to record what PPE they were wearing at the time of injury.

According to readily available manufacturer literature, gloves constructed of either NOMEX® or KEVLAR® are flame retardant and provide protection against flame up to 800 degrees F. Both products are commonly used in the construction of fire protection, racing, and military clothing. Current Rapid Fielding Initiatives (RFI) implemented for deploying Army Soldiers include the issue of gloves comprised of these materials.

Our recent experience in the treatment of combat casualties supports your own conclusions that the use of gloves constructed of NOMEX or KEVLAR to Marines would decrease the incidence and severity of hand burns related to combat operations. Our experience supports your efforts to encourage issuing this equipment to Marines as a standard item of deployment equipment. Please let me know if I may be of any further assistance to you in the future.

JOHN B. HOLCOMB
Colonel, MC
Commanding

United States Army Institute of Surgical Research

Analysis of thermal injuries sustained during vehicular maneuvers in Operations Iraqi and Enduring Freedom

Rationale

Thermal injuries have historically been common in combat operations, and have remained so during current operations in Iraq and Afghanistan. Battle injuries with burns as the primary problem currently comprise 5 percent of evacuated casualties. Especially at risk are individuals traveling in vehicle convoys which have been targets of improvised explosive device (IED), vehicle-borne IED (VBIED), rocket-propelled grenade (RPG), and landmine attacks. These individuals are also at risk for burns sustained in motor vehicle crashes during convoy operations.

All patients with significant burns sustained in Operations Iraqi and Enduring Freedom (OIF and OEF) requiring evacuation are cared for at the United States Army Institute of Surgical Research (USAISR). The XVIII Airborne Corps has requested information from the USAISR on the pattern of burn injury and outcomes of individuals wounded during convoy operations. They have also asked for an assessment of the impact of combat burns and recommendations as to the potential utility of fire-retardant clothing in the prevention of such injuries.

Data Sources

The following analysis contains data compiled from the USAISR Burn Center Census database and the BAMC/USAISR trauma registry. The data covers injuries occurring between 5 April 2003 and 23 April 2005. The databases used to compile this analysis did not always have complete representation of the mode of injury (i.e. what the individual was doing when they were injured). There are 81 patients included in this analysis with the assumption that injuries sustained as the result of IED, VBIED, and rocket-propelled grenade RPG attacks occurred during vehicle maneuvers.

This analysis includes only those patients treated at the USAISR burn center. Data on individuals who died in theater or during evacuation and on those who were treated at other facilities are not included, but these represent a very small number of burn casualties. It is unknown how many burn patients were treated in theater and returned to duty. The vast majority of evacuated (thus significant) burn casualties from the global war on terrorism are cared for at the USAISR and are analyzed here.

Data Analysis

Burn patient population

There have been 274 OIF/OEF patients admitted to the USAISR Burn Center, with a mean total body surface area (TBSA) burned of 14 percent (**Table 1**). The acuity of burn injury and mortality this population has increased with time.

Population	2003	2004	2005 YTD	Mean
Patients	89	124	61	Total 274
Mean % TBSA	11.9	13.8	16.2	14.0
% ICU Admissions	26	38	39	34
% Ventilator	23	36	44	34
% Mortality	1.1	4.0	3.3	2.8

Table 1. OIF/OEF patient population treated at the USAISR Burn Center

- The number of patients has increased from 2003 to the present
- The mean burn size has increased from 2003 to the present
- The acuity of burn injury has increased from 2003 to the present

Burn injuries over time

Combat-related burns have increased in frequency, with a corresponding decrease in non-combat related injuries over time **(Figure 1)**.

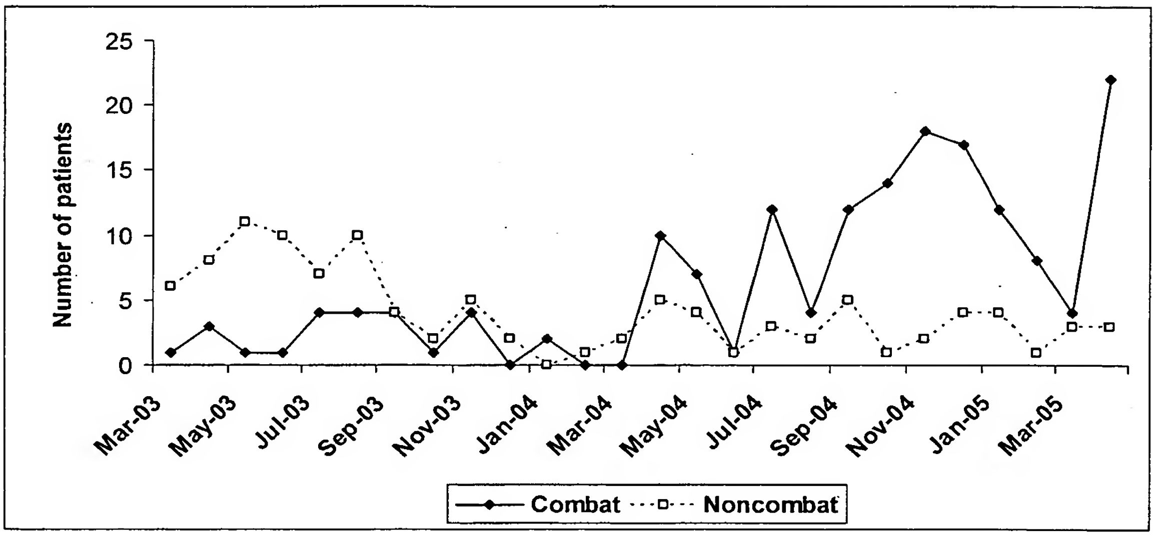

Figure 1. Combat and noncombat burns in OIF/OEF patients from the USAISR

- The frequency of noncombat burns decreased after Sept-03, and has remained constant since then
- There has been an overall increase in combat-related burns since Apr-04

Mode of burn injury

The frequency of explosion-related injuries from IED, VBIED, or RPG detonations is increasing. This has contributed to the increased in severity and acuity of burn injury seen over time **(Table 2)**.

Mode of Burn	2003	2004	2005	Total
Noncombat (%)	70 (79)	32 (26)	13 (21)	115 (42)
Combat (%):	19 (21)	92 (74)	48 (79)	159 (58)
IED	3 (16)	56 (61)	22 (46)	81 (51)
VBIED	0 (0)	15 (16)	14 (29)	29 (18)
RPG	9 (47)	14 (15)	7 (15)	30 (19)
Mine	4 (21)	0 (0)	1 (2)	5 (3)
Other	3 (16)	7 (8)	4 (8)	14 (9)

Table 2. Mode of burn injury in OIF/OEF patients treated at the USAISR Burn Center

- Burn resulting from explosions have increased from 2003 to the present
- IED's represent the majority of injuries
- IED and VBIED burns are increasing in frequency

Population of OIF/OEF patients burned in vehicle operations

A total of 126 patients (46 percent of the OIF/OEF burn population) sustained these injuries during vehicle operations. The mean age was 26 years (range 18-48 years). The burn size has increased from 2003 to 2005, as have the overall injury severity scores (ISS), indicating not only an increase in burn acuity but also more frequent and severe associated nonburn injuries **(Table 3)**.

	2003	2004	2005 YTD
Patients	17	77	32
% TBSA	16.1	12	19.5
ISS	7.4	9.3	14.4

Table 3. Population characteristics of OIF/OEF burn patients

- 126 patients were burned in vehicles
- Average burn size and overall ISS have increased from 2003

Mode of burns occurring during vehicle maneuvers

The majority of burns occurring in OIF/OEF were as the result of an explosion on or near a military vehicle. The mode of burn injury parallels that of the overall combat-associated burn population, with IED, VBIED, and RBG explosions accounting for nearly all of the burns **(Figure 2)**.

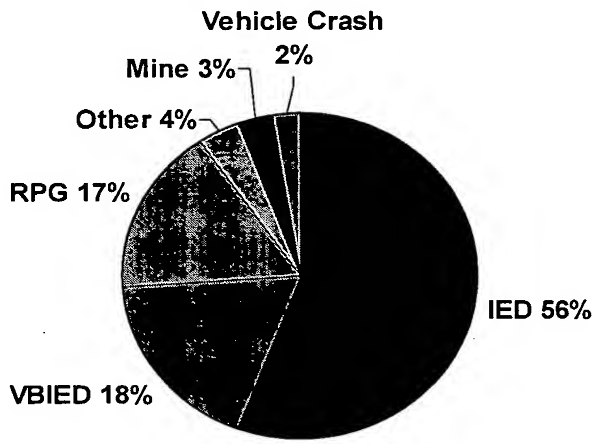

Figure 2. Vehicle-Associated Burns
- 126 (46 percent) of OIF/OEF burns were sustained in vehicles
- The mean age was 26 years (range 18-48 years)
- Overall mortality was 4 percent (5/126)
- The most common mode of injury was IED, followed by VBIED, and RPG
- Unknown modes of injury are placed in the "other" category

Pattern of vehicle-associated burn injury

The hands and the head are the areas of the body with the greatest frequency of burn injury **(Figure 3)**. Areas covered by uniforms and personal protective equipment (PPE) such as the torso and legs, despite their larger surface area, suffer relatively fewer burn injuries.

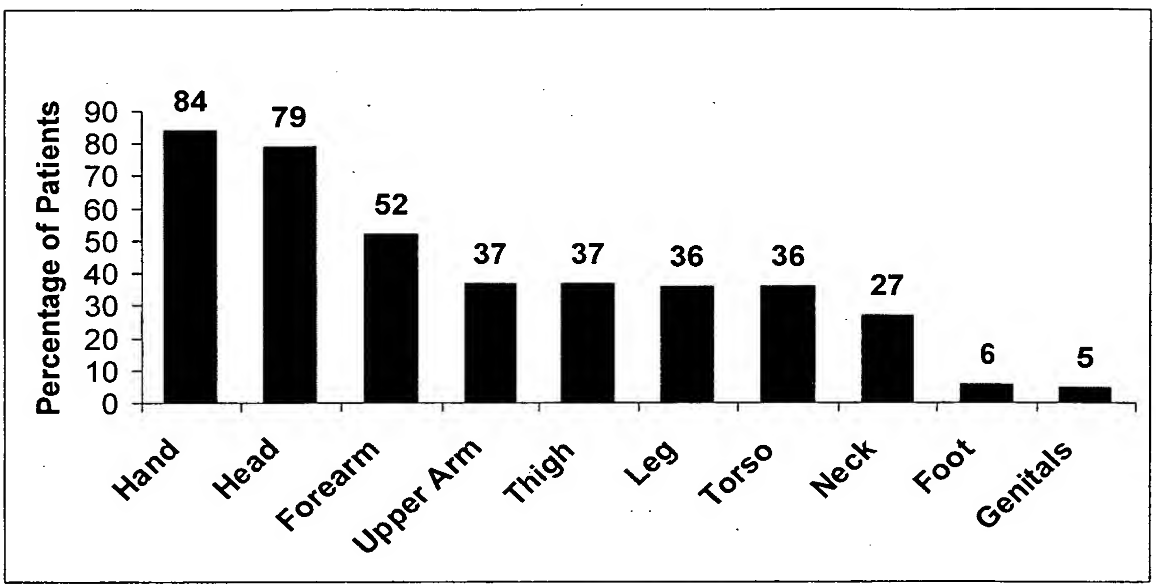

Figure 3. Pattern of burn injury in vehicle-associated wounding

- Areas unprotected by uniforms and PPE suffer burns relatively more frequently
- Seven percent of patients had burns isolated to the hands. Twenty percent had burns isolated to the head and/or hands
- Head burns occurred primarily on the face

Pattern characteristics by TBSA at risk in vehicle-associated burns

The mean total body surface area (TBSA) burned was 14.4 percent (median 7.0 percent, range 0.26-95 percent). The thigh (7.5 percent), torso (6.5 percent), and leg (5.7 percent), though not the most frequently burned, were the body areas contributing the most to total TBSA burned. The percentage of each body area burned by the TBSA at risk for injury in each area is presented in **Figure 4**.

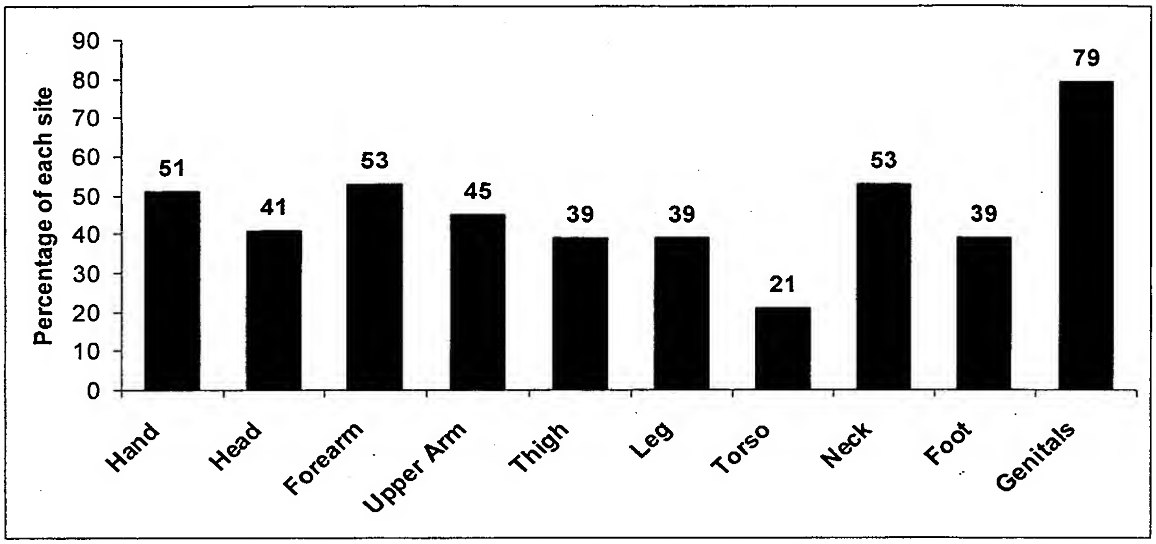

Figure 4. Percentage of at-risk TBSA burned by body area

- The hands suffered burns covering over half of their surface area
- The head was burned over forty percent of its surface area

Outcomes from vehicle-associated burns

The military disposition of OIF/OEF patients (126 casualties) treated at the USAISR Burn Center after vehicle-associated burns was return to duty in 36 percent of cases. 21 percent underwent or have pending Medical Evaluation Boards (MEB), and will not return to service. Some were returned to duty with profiles and are still receiving intermittent care at the USAISR, and others have disposition decisions pending **(Figure 5)**.

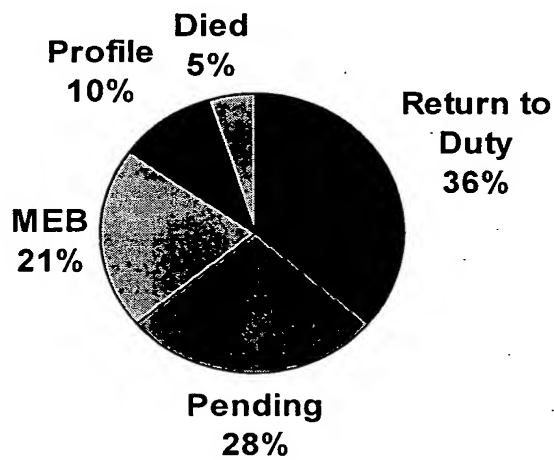

Figure 5. Military disposition

- Overall mortality among patients burned in vehicles was 5 percent (6/126)
- Global functional assessment:
    - 88 percent of patients were discharged at their previous level of global functioning
    - 6 percent were discharged with moderate disability but able to care for themselves
    - One patient had severe disability, unable to care for himself
- Length of stay:
    - The mean length of stay at the USAISR burn center in this population was 23 days (median 14 days, range 1-117 days)
    - At the time of writing, 13 individuals remained inpatients and are not included in disposition data
- Disposition:

- 91 percent of patients were discharged to their own care
- The remainder were dispositioned to inpatient rehabilitation facilities

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Conclusions

Burns are a frequent source of combat injury in OIF/OEF, and have increased in frequency and severity with the increasing frequency of attacks by explosive devices in the Iraq and Afghanistan theaters of operation. The majority of burns sustained during vehicular maneuvers in OIF and OEF were of small surface area, and global measures of patient outcome were nearly universally good. The small size of the vehicle-associated burns belies their impact on the patients and the mission, however. As the frequency of explosion attacks by IED's and VBIED's has increased, so has the number and severity of associated injuries in burned patients. This is reflected in the increased acuity and mortality of OIF/OEF burn patients over time.

The hands and head were the body areas most likely to have sustained burns. The American Burn Association recommends that patients with even small, isolated burns to the hand or face be transferred to a burn center for treatment. Despite their small size, facial and hand burns can be some of the most morbid of burn injuries. The burns to the hands seen in the military population tend to be much worse than those seen in civilians. This is due to increased burn thickness as well as greater involvement of the palms. Palmar burns have potential for chronic morbidity from contractures and are difficult to rehabilitate. The need for chronic specialized care and the significant functional limitations resulting from many hand burns result in casualties with these injuries being removed from duty for extended periods or leaving military service altogether.

Recommendations

Areas covered by the battle dress uniform and body armor such as the torso and legs were relatively spared in this population. The pattern of injury seen likely represents the protective effect of the wounded patients' clothing and PPE such as the helmet. Significant portions of the burn injuries were isolated to the hands and head, indicating that protecting these areas from burn injury through the broader use of protective garments or devices might be expected to significantly reduce the total number of thermal injuries in this population. The use of protective garments on the hands and head/face alone might result in not only a reduction in the overall number of burn casualties, but also in decreased burn severity, morbidity, and potentially increased return-to-duty rates among soldiers that are burned.

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Security classification: FOUO

End Notes

[1] From II MEF thermal injury data provided by CDR Doug Welch, II MEF G-4 Planner, 23 October 2005.

[2] Galarneu, Michael, Naval Health Research Center, phonecon with LtCol R. Liebe, MCCLL, 26 October 2005.

[3] From Naval Health Research Center Combat Trauma Registry data, provided by Mr. Mike Galarneau, 25 October 2005.

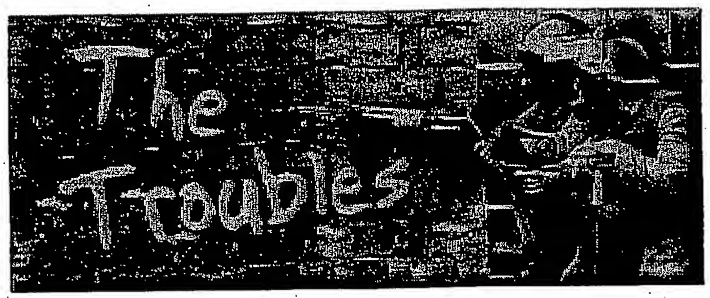
[4] Holcomb,COL John, "Analysis of thermal injuries sustained during vehicular maneuvers in Operations Iraqi and Enduring Freedom (FOUO)", US Army Institute of Surgical Research, obtained via e-mail 24 October 2005.

[5] Coakley, LCDR Tim, US Army Institute of Surgical Research, E-mail exchange with LtCol R. Liebe, 24 October 2005.

[6] www.gsaadvantage.gov, last accessed 25 October 2005.

[7] Hill, Peter, Headquarters, Marine Corps Safety Division, E-mail documenting results of 12 October 2005 test of ghillie suits treated with commercial fire retardant.

[8] Interviews with Mr. Louis Curcio, MARCORSYSCOM Infantry Combat Equipment program manager, and Maj Pat Cashman, MCCDC Capabilities Development Division, Fire and Maneuver Branch, 21 October 2005.



Principal Events

1969	
July	Civil rights march in Londonderry broken up by 'B Specials'
August	First British troops sent to Northern Ireland
1970	
June	Army imposes 24-hour curfew on Falls Road area, Belfast, conducts house-to-house search for terrorists; 5 people killed.
1971	
9 August	Internment without trial introduced
4 December	Protestant terrorists kill 15 Catholics with a bomb in a Londonderry bar
1972	
30 January	British paratroopers kill 13 Catholic demonstrators in Londonderry, on Bloody Sunday
22 February	IRA bomb in a bar in Aldershot, England kill 7 British soldiers
March	Stormont Parliament dissolved. Britain imposes direct rule on Northern Ireland
1973	
11 November	Power-sharing executive set up by Unionist, SDLP and Alliance parties
6-9 December	Conference at Sunningdale in England between British and Irish governments and the 3 parties. Agree to a 'Council of Ireland'.
1974	
May	Strike by protestant Ulster Worker's Council forces abandonment of executive and Sunningdale proposals
17 May	Car bombs in Dublin, planted by protestant terrorists, kill 22 people
5 October	Four soldiers and one civilian were killed and 65 were injured when two pubs were bombed in southern England.
21 November	IRA bombs in two pubs in Birmingham kill 21
1976	
4 January	5 Catholics murdered in County Armagh
5 January	10 protestant workers killed on a bus, in reprisal
21 July	British ambassador to Dublin killed by a bomb
1978	

17 February	IRA bombs at the Le Mon café, Belfast, kill 12
1979	
22 March	British ambassador to the Netherlands killed
30 March	Airey Neave, MP, killed by car bomb at the House of Commons
27 August	Bomb kills 18 British soldiers at Warrenpoint, Northern Ireland. Lord Louis Mountbatten and 3 others killed by bomb on his boat at Sligo, Ireland
1980	
October	First IRA prisoners' hunger strike. Called off 18 December
1981	
1 March	Bobby Sands begins hunger strike; he dies 5 May. 9 other IRA prisoners eventually starve themselves to death
1982	
22 July	11 British soldiers killed in two bombings in London, one under a bandstand in Regent's Park
6 December	Irish national Army bombs disco in Ballykelly, killing 11 soldiers and 6 civilians
1983	
17 December	Car bomb outside Harrods department store in London kills 5 people, wounds more than 80
1984	
12 October	IRA bomb in the Grand Hotel, Brighton, during the annual Tory party conference, kills 4, narrowly missing Margaret Thatcher
1985	
28 February	IRA mortar attack on police barracks at Newry kills 9 policemen in a cafeteria
15 november	Margaret Thatcher and Garrett Fitzgerald sign Anglo-Irish treaty
1987	
March	Gunfights between rival Republican terrorists kill 12
25 April	Ulster Chief Justice Maurice Gibson and his wife assassinated by a bomb
8 May	3 senior IRA men and 5 other terrorists killed in an ambush at Loughgall
8 november	11 civilians killed during an Armistice day service at Enniskillen
1988	
6 March	3 IRA terrorists shot by British SAS in Gibraltar
16 March	3 people killed by a protestant during the Gibraltar terrorists' funeral
19 March	2 British soldiers lynched during the funeral of the victims of the 16th March shooting
2 May	3 RAF men killed by bombs in Holland
15 June	6 British soldiers killed by car bomb at sports event
1 August	1 Soldier killed by bomb in army barracks in London
20 August	8 Soldiers travelling from Belfast airport killed by bomb
30 August	3 IRA gunmen killed by security forces

31 August	2 IRA suspects arrested crossing West german border from Holland, carrying explosives. Elderly Catholic couple killed by IRA booby-trap in Londonderry
12 September	Bombs demolish home of head of Northern Ireland civil service. Car bomb in belfast injures 12.
24 November	67-year-old Catholic and his 11-year-old granddaughter killed by IRA bomb; 8 other civilians wounded. As after 31st August bombing, and Enniskillen, the IRA apologizes.
1989	
14 March	18 policeman reprimanded in Northern Ireland for the death of five IRA suspects in 1982, in the shoot-to-kill or Stalker affair
8 September	German wife of British soldier shot in Germany
22 September	10 Royal Marines killed by bomb in Royal Marines School of Music, near Deal, Kent
19 October	Guildford Four released and convictions for the 1974 pub bomb overturned
26 October	RAF corporal and his six-month-old child killed by two IRA gunmen in Germany
1990	
12 January	4 IRA men arrested in florida trying to buy Stinger anti-aircraft missiles from undercover FBI agents
16, 20 June	Dutch police arrest 6 IRA terrorists involved in attacks on British troops in Germany
25 June	Bomb in Carlton Club, London, kills porter
20 July	Bomb in London Stock Exchange
30 July	Ian Gow, Tory MP and close friend of Prime Minister Thatcher, killed by a car bomb
19 September	IRA attempts to kill Sir Peter terry, in Staffordshire. he was governor of Gibraltar when teh 3 IRA terrorists were shot by police. he and his wife were wounded.
24 October	7 Killed, 37 wounded ins eries of proxy car bombings in northern Ireland. hostages were forced to drive cars with bombs in them at terrorists' targets
1991	
7 February	IRA squad launches mortar attack on 10 Downing Street from Whitehall, no casualties.
18 February	Bombs exploded in Paddington and victoria stations, London. One killed.
14 March	Birmingham Six freed after 16 years in jail; courts ruled their confessions were 'unsafe and unsatisfactory'
30 April	Preliminary talks open at Stormont between Protestant and Catholic parties and British on power sharing
1 June	3 Soldiers killed by car bomb attack on army base at Glenanne, Armagh
2 June	Senior civil servant, a woman loses both legs in bomb attack; IRA apologizes
3 June	3 IRA gunmen killed by police in ambush 30 miles west of Belfast
17 June	Round-table talks on future of Northern Ireland open in Stormont
3 July	Stormont talks abandoned because of protestant intransigence
13 November	IRA shoots 4 men in Belfast, claiming they were members of protestant death-squads. Another man and six-week-old baby wounded.
15	

November	Two terrorist, a man and a woman, blow themselves up with their own bomb in St Albans
1 December	Firebombs set off against shops in London
December	Car bomb severely damages Belfast opera house and Europe hotel
1992	
6 January	2 car bombs do great damage to centre of Belfast, and a firebomb set off in Oxford
10 January	Bomb in whitehall damages government buildings

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	PAT. NO.	Title
1	6,996,474	Automated method for identifying related biomolecular sequences
2	6,996,466	Method of controlling vehicle handling by influencing the yaw velocity
3	6,995,825	Process for preparing films of polymerized liquid crystal material having a first film of a polymerized liquid crystal material with uniform orientation and a second film of a polymerized liquid crystal material with uniform orientation directly on the first film
4	6,995,291	Process for the oxidation of unsaturated alcohols
5	6,995,286	Process for preparing isomers of salbutamol
6	6,995,285	ABCA-1 elevating compounds
7	6,995,283	Benzophenones as inhibitors of reverse transcriptase
8	6,995,280	Process for preparing (mercaptoorganyl)alkoxysilanes
9	6,995,278	Antiangiogenic agents
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14	6,995,270	Hydrogenation process
15	6,995,263	Indolyl and dihydroindolyl derivatives, their manufacture and use as pharmaceutical agents
16	6,995,262	Use of acylsulfonamido-substituted polymethine dyes as fluorescene dyes and/or markers

17 6,995,247 Ac-HEHA and related compounds, methods of synthesis and methods of use
18 6,995,231 Extrudable highly crystalline thermoplastic polyurethanes
19 6,995,230 Stabilizers, in particular for thermoplastic polyurethanes
20 6,995,227 Activator compositions for cyanoacrylate adhesives
21 6,995,223 3,4-alkylenedioxy-thiophene copolymers
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48 6,995,122 Method for imparting substantive fragrance and, optionally, anti-static properties to fabrics during washing and/or drying procedure and compositions useful for effecting such processes
49 6,995,113 Catalysts which are based on organic-inorganic hybrid materials containing noble metals and titanium and which are used for selectively oxidizing hydrocarbons
50 6,995,110 Complex catalyst, process for producing the complex catalyst, and process for producing alcohol derivative with the complex catalyst

RELATED PROCEEDINGS APPENDIX

There are no related proceedings in connection with the subject application.